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USING TOUCHMATH TO INCREASE MATH SKILLS OF YOUNG ENGLISH LANGUAGE LEARNERS WITH MILD TO MODERATE DISABILITIES

by

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Abstract

USING TOUCHMATH TO INCREASE MATH SKILLS FOR YOUNG ENGLISH LANGUAGE LEARNERS WITH DISABILITIES

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This study examined the effectiveness of TouchMath as a mathematics instructional strategy for English language learning kindergarten students with mild to moderate disabilities to learn basic math skills. The basic math skills examined in this study were oral counting, number identification, missing number, quantity discrimination, addition, subtraction. A multiple baseline across participants design was used to evaluate the use of daily TouchMath lessons with five students who are English language learners and have been identified with mild to moderate disabilities. Curriculum based measurement probes were used to measure the effectiveness of TouchMath instruction. All participants increased their number of correct responses in basic numeracy skills.

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TABLE OF CONTENTS

CHAPTER 1

Introduction

Currently, there is very little attention given to the availability, use, and importance of appropriate math curricula, programs, and instruction for kindergarten students with disabilities (Van Luit & Schopman, 2000). When students with learning disabilities are older, special educators are able to scaffold and differentiate math curricula. However, while students with disabilities are in kindergarten, teachers have a more challenging time differentiating and scaffolding math curriculum because the skills to be taught to, and to be learned by kindergarten students, are the initial and primary math skills that lay the foundation for higher order thinking math that comes in first grade and beyond (Van Luit & Schopman, 2000). Typically, teachers turn to popular methods and strategies or an alternative learning program, such as TouchMath, or develop a curriculum of their own by collecting strategies, methods, worksheets, and ideas from a variety of resources to try and successfully teach math to their kindergarten students with disabilities.

This research, which analyzes the efficacy of a multisensory math curricula, TouchMath, for kindergarten English Language Learner (ELL) students with mild to moderate disabilities is important for special education teachers that are facing challenges in teaching daily math lessons to students with disabilities, primarily those in kindergarten. TouchMath is a widely known program that has been available for nearly 30 years. TouchMath is a multisensory method for teaching math in which math is broken down into small and logical steps without requiring the storage of arithmetic facts in memory (Avant & Heller, 2011).

Problem Statement

Mathematic skills are as important as literacy skills (Daly & McCurdy, 2002). Great attention and care is taken in teaching literacy skills and the same should be applied to mathematics instruction. If the acquisition of math skills is viewed in the same way as acquiring literacy skills, an order of skills attained systematically over time provides the foundation for more advanced skills students need to process math formulas and computations. Number recognition, much like alphabet recognition, is a first step in acquiring future mathematic skills and with that, an early numeracy program, much like a phonics program, would also benefit students in learning mathematics (Van Luit & Schopman, 2000). However, most research on effective math instruction using a particular math curriculum or program has been for students in first to twelfth grade. The need for finding the most commonly used and effective math curricula for students with disabilities, primarily those students in kindergarten, is vital to the future of young students with disabilities (Rhymer et al. 2000). Additionally, there is a great need for supporting ELL students with disabilities in learning mathematics because language and math are connected and using research based multimodal/multisensory instructional strategies can promote their success in mathematics learning (Brice & Roseberry-McKibbin, 1999; Langdon, 1996; Dale & Cuevas, 1992).

As Daly & McCurdy indicate (2002), there continues to be a great need for more research studies on effective math instruction strategies for students in kindergarten so they can develop the requisite skills to be successful in the core curriculum of study as well as progress through the grades with and without specialized services. Therefore, having information to identify the most effective math curricula and programs in special education classrooms for ELL kindergarten students with disabilities will help teachers provide their students with the early math skills necessary to meaningfully participate in general education classroom environments.

Purpose

The goal of this research was to determine if a research based strategy, TouchMath, is effective in teaching math to students with disabilities, primarily those in kindergarten and who ELL are. As a result, this study provides teachers of kindergarten students with disabilities with recommendations for appropriate math curricula and programs, as well as strategies and intervention programs for their young students with disabilities.

To provide a research based effective strategy for teachers to successfully teach math to their students with disabilities, a research study on a single group of student, all the age of 5 years old, in kindergarten was conducted. The students were in a special day class setting where they received academic instruction and other special education services. The research consisted of five students receiving TouchMath instruction in a multiple baseline design. These data were analyzed and interpreted for the purposes of determining if TouchMath was an effective strategy for teachers of kindergarten students with mild to moderate disabilities.

Researcher Background

Currently, I am in my third year of teaching a Communication and Social Skills Special Day class for grades kindergarten, first, and second. Prior to becoming a teacher, I was marketing and communications director for a non-profit organization where I promoted the organization, did fundraising events, and helped the smaller organizations and individuals we served through workshops and general support. It was through those experiences that I began to hone my skills as a communicator. It also brought me into contact with various groups of people which broadened my horizons. I found myself drawn to individuals who were historically underserved which in a twist of fate (I was laid off) led me to my current field in special education. This unfortunate set of circumstances was a blessing in disguise because I was able to pursue an interest in teaching that was not being realized in the field of business. The day after I was laid off in July of 2009, I called the teaching program at California State University Monterey Bay and after going through the application process, I was admitted to the Special Education credential program for the fall term which was a few short weeks away. During the 3 years since I have started my education, I have had the opportunity to explore different areas of special education through practicum and volunteer work and it was during my practicum that I discovered how much I truly enjoyed teaching and working with the younger students. At the end of my practicum, I was offered a position teaching kindergarten, first grade, and second grade students with disabilities in a special day classroom setting which is also a class that is specifically designed for students with autism, speech and language impairment, and deaf/hard of hearing.

Research context and rationale. I currently work in a public school classroom teaching kindergarten, first grade, and second grade students with disabilities in a special day classroom setting and have been for the last 3 years. Since I began teaching, I found that the core curriculum made available for my students is not effective as it requires a lot of modifications and adoptions, additional use of manipulatives, as well as changing the sequence of skills presented. For the last two years, I have been searching for a program that is effective in teaching mathematics to kindergarten, first grade, and second grade students with disabilities who may also be English Language Learners. While searching for an effective math program, I attended a TouchMath workshop and discovered that other special educators of the upper grades currently using TouchMath found it to be effective with their students. This discovery led me to wanting to research its effectiveness with the younger students so that I may better prepare them for their inclusion in the general education classroom.

Theoretical Model

The use of neurodevelopment and sensory motor integration to teach children with and without disabilities (Ayres, 1972; Frostig, 1972; Kephart, 1971; Cratty, 1964) continues to be an instructional model that educators use to teach students with disabilities. This early research in the area of sensory motor education created the foundation for what is commonly known today as multisensory and multimodal approaches to teaching children with disabilities (Youssefi & Youssefi, 2000). Scott (1993) indicated that this early research made it possible for children with disabilities to learn through a sensory motor integration approach thus meeting their individual educational needs.

Of the many researchers, Kephart (1971) stands out as one of the most influential thinkers in furthering research and theory regarding sensory motor integration to teach children with disabilities (Youssefi & Youssefi, 2000). The main premise for Kephart's research revolved around the notion that in order for learning to take place in a way that children can process effectively, perception and movement had to simultaneously be coordinated with a wide variety of sensory experiences and movement opportunities (Kephart, 1960; Arnheim & Sinclair, 1975). Hannaford (1995) corroborated Kephart's research postulating that through organized movement, sensory processes, and brain integration the ability to learn happens naturally and willingly.

At the same time Kephart (1960; 1971) was developing his theories, Ayres (1972), Cratty (1964), and Frostig (1972) were developing versions of their own theories that complemented Kephart's work in the area of sensory motor integration. These researchers captivated the attention of educators during the 1970s and 1980s and their techniques and strategies could be found in classrooms for students with disabilities throughout the nation. However, with new evidence based strategies for teaching reading and math, sensory motor integration, that lacked solid research to back its claims, fell by the wayside in favor of more progressive methods. Interestingly, sensory motor integration continues to be part of the educational landscape as evidenced by the programs such as TouchMath. Knowing that sensory motor integration has a strong and powerful history and past with eminent thinkers who helped shape the field of special education, the method cannot be dismissed. Conducting studies to analyze the effectiveness of various sensory motor integrative approaches still needs to be at the forefront so that testimonials, though important, give way to research in order to, with some degree of confidence, endorse a method to be used with children with and without disabilities.

Research Questions

Within this context, the research questions are as follows:

- Does TouchMath impact the addition skills of ELL kindergarten students with disabilities in a special education setting?
- Does TouchMath impact the subtraction skills of ELL kindergarten students with disabilities in a special education setting?
- Does TouchMath impact the numeracy skills (i.e. oral counting, number identification, number order, and number representation) of ELL kindergarten students with disabilities in a special education setting?

Definition of Terms

Curriculum Based Measurement (CBM): A researched-based assessment which focuses on short tests, called probes, to ascertain student achievement on basic skills in reading, math, writing, and/or spelling.

Math Skills: For the purposes of this study, the term, "math skills", will be used to refer to numeracy/numbers, addition, subtraction, geometric objects, and mathematical reasoning.

Numeracy: oral counting, represent, recognize, name, and order.

Special day class education math curriculum: math curriculum that is for or can be for students with disabilities in a general or special education setting.

General education math curriculum: math curriculum that is for without disabilities students in the general education setting.

TouchMath: a multisensory math instruction program that uses its signature TouchPoints (on the numbers) (Bullock et al., 1989).

Students with disabilities: refers to students whose primary disability is one of the following: Speech and Language Impairment, Autism, or Intellectual Disability. These disability categories, as identified by the Individuals with Disabilities Education Act (IDEA), are the primary disabilities of the population of students included in this study.

CHAPTER 2

Literature Review

Currently, there is very little focus on the availability and use of appropriate math curricula for kindergarten students with disabilities. The purpose of this literature review is to analyze research that investigates the differences between general and special education mathematics instruction and interventions, and using TouchMath as a successful alternative to teach mathematics to students with disabilities. The review includes an overview of research on mathematics instruction and interventions at the lower grade levels, research on English language learners (ELL), the use of manipulatives/multisensory Interventions for ELL students with disabilities and mathematics, and TouchMath.

An Overview of Mathematics Instruction and Interventions at the K-2 Levels

The primary method for teaching mathematics at all grade levels is the textbook (Nicely, Fiber, & Bobango, 1986). In the general education setting, a district-assigned mathematics instruction curriculum is used for each grade. This curriculum often consists of textbooks and workbooks for each student, a teacher guide, and a pacing calendar. Sometimes, supportive materials, such as transparency sheets, manipulatives, and other objects, are included to help the teacher deliver instruction.

There is no particular or specific way to teach math successfully to kindergarten students, with or without disabilities. One potential approach to improving math success in our kindergarten students is the delivery of an effective core instruction program to set a strong foundation for mathematical understanding that would prevent difficulties in mathematics during their primary grade years (Chard, et al, 2008). But any core program would need to include the one skill that most researchers can agree on that leads to the successful ability to solve basic arithmetic problems, and that is number sense, also referred to as an early numeracy program (Van Luit & Schopman, 2000). Additionally, there are alternatives to the classic textbook program, including the cover-copy-compare (CCC) method and the implementation of an early numeracy program, both of which have been researched and have concluded to help young learners with and without disabilities successfully learn math. Because of their importance as mathematics intervention programs for young learners, they will be discussed in some depth.

Cover-Copy-Compare (CCC) Approach

The Cover-Copy-Compare (CCC) approach is an effective intervention for students who have difficulty with learning math facts and need to increase math fluency at any grade level (Grafman & Cates, 2010). Cover-Copy-Compare is an intervention that provides a series of learning trials within a short period of time and utilizes three basic components: the student studies a sheet of paper with a list of math problems on the left side, the student covers the math problems then copies them on the right, finally, the student compares their response to the ones provided on the left (Poncy, Skinner, & Jaspers, 2006).

The CCC approach provides students repeated practice and corrective feedback which have been found to increase accuracy and automatic responding to basic math facts (McCallum et al. 2004). However, CCC is only effective if the student produces accurate responses in the "copy" step of the CCC method (Skinner et al., 1997). Prior to teaching math facts and considering CCC as an intervention, students must first learn about numbers, also known as numeracy.

Early Numeracy Interventions

Research has suggested other ways in which students with disabilities in the lower grades can achieve success in mathematics. Van Luit and Schopman (2000) studied how kindergarteners in special education learn, retain, and transfer required math skills. Their program alternated between concrete, semi-concrete, and abstract levels to facilitate children's learning ability to learning and transfer counting. Specifically, it made use of tally marks, in groups of 5, as "perceptual gestalts" (p. 30) to help children make the connection between a concrete representation of a number and its abstract symbol. After six months of instruction, children using this program significantly outscored a comparison group in early numeracy, counting and general understanding of numbers; however, the groups did not differ significantly with respect to transfer of new knowledge. Results supported the idea that it is critical to teach young children with special educational needs an initial number sense very early on, prior to entering first and second grades, and that remediation should be tailored to each specific student's individual needs (Van Luit & Schopman, 2000).

Despite the way instruction and intervention is delivered, whether it is a textbook or teacher made materials, there is a common ground for what skills are to be learned with young learners in kindergarten. In preschool and kindergarten, number sense and number competence are the key skills taught. This commonly consists of rote counting, comparison of quantity, 1:1 correlation, cardinal value, simple addition and subtraction, 'number after' and 'number closer to' (Clements & Sarama, 2008; Clements, Sarama, & Liu, 2008). Mulligan, Mitchelmore, & Prescott also suggest that learning and having a sense of pattern and structure is another component for future mathematical success (2005). It is said that the ability to identify numbers, discriminate between quantities, and identify missing numbers in sequences by the end of kindergarten provides a strong gauge on the success in mathematics by the end of first grade (Chard et al., 2005; Clarke & Shinn, 2004).

As students move to the first grade, the math skills required to be successful become more complex and challenging to learn. By first grade, children are required to apply their number knowledge learned in kindergarten to solve problems presented in the curriculum. In 2006, the National Council of Teachers of Mathematics recommended that students develop recall of the basic addition and subtraction facts by the end of second grade (2006). However, California had already created and implemented an earlier timeline for such skills to the end of first grade and stated that students must "commit them to memory" (California Board of Education, 1999). Learning these math skills by the end of first grade can be challenging for some students, especially if they are an English Language Learner (ELL) and/or have an IDEA recognized disability (Gutierrez, 2002; Hoover & Patton, 2005). The lack of a curriculum that meets the diverse needs for students with disabilities and ELL students with and without a disability is reason why learning math skills can be challenging for them (Hoover & Patton, 2005).

The No Child Left Behind (NCLB) Act of 2001 requires that ELL students and students with disabilities have access to and be held to the same content standards and curriculum as well as be assessed on the same grade level achievement standards as their peers (U.S. Department of Education). With this, it is important to provide further review of the ELL student and the student with a disability to better understand and meet the needs of these groups of students.

English Language Learners and Mathematics

Math has been referred to as a "universal language" and when it comes to learning it, the ELL student, especially younger students, often have difficulty deciphering and learning mathematics vocabulary and skills (Hoover & Patton, 2005; Dale & Cuevas, 1992). It is difficult because math and language are intricately connected where language facilitates math learning, thinking, and the acquisition of skills (Dale & Cuevas, 1992). Supporting the ELL student in math learning can be done in many ways and it is recommended that educators focus on several key teaching and learning principals instead of one specific program model that works for ELL students (August & Hakuta, 1998).

ELL students need to be in a learning environment where they have access to curricula and instruction that integrate basic skills development along with higher order thinking (Ortiz & Wilkinson, 1991). Using research based instructional strategies and a multimodal approach to learning is very effective in mathematics for the ELL student- and the ELL student with a disability (Brice & Roseberry-McKibbin, 1999; Langdon, 1996). This further supports Ortiz and Wilkinson's (1991; 1997) two critical elements that are essential to the success of ELL students: the creation of advantageous education environments for their academic success and the use of instructional strategies known and proven to be effective with ELL students with and without disabilities.

Multisensory Approach and Mathematics Teaching

Multisensory education has historical roots in teaching students with disabilities. For decades researchers Kephart (1960; 1971), Frostig (1972), Ayres (1972), and Cratty (1964) developed a theoretical approach to teaching students with learning challenges that utilized sensory integration methods to remediate problems associated with reading and mathematics. These approaches centered around coordinating gross and fine motor movements as well as visual and spatial integration. In fact, the term sensory motor integration emanated from the work of these seminal researchers trying new ways for students to use all of their senses to process information, attend to and persevere to task, and to respond appropriately to relevant information (Ayres, 1972; Frostig, 1972; Kephart, 1971; Cratty, 1964). Sensory integration approaches helped students coordinate and pursue across the page so they could read better, use manipulatives so they could "feel and touch math" in order to demystify abstract formulas, and to write with some degree of proficiency (Biggs & Collis, 1991; Thornton, Jones, & Toohey, 1983). Though sensory integration and multisensory approaches have been criticized and "debunked" as a viable evidence based approach, the methods continue to surface in different forms with different names (e.g., Brain Gym, SMART Moves) (Kavale & Mattson, 1983). The sensory motor historical roots, as mentioned above, persist to this day and educators are drawn to it because they see benefits for their students, find the methods compelling, and anecdotally note changes in student performance in reading and math. In fact, manipulatives used to teach math are ubiquitous in classrooms all over the United States and derived from sensory motor concepts and ideas put forward by early researchers (Thornton, Jones, & Toohey, 1983).

Manipulatives are concrete material models that involve mathematical concepts which are appealing to several senses (including the socio-cultural needs) that involve active touch; they can be touched and moved around (Olkun, 2003). The use of manipulatives benefits students across grade and ability levels (Durmus & Karakirik, 2006). In addition, manipulatives help children learn more, enhances their learning, and reduces their anxiety about mathematics (Heuser, 2000). For children with disabilities, the use of manipulatives is very effective because it allows for flexibility with different ability levels and needs, channels their strengths, and helps them make connections in mathematics with concrete and pictorial representations (Funkhouser, 1995).

For young students with and without disabilities, specifically those in kindergarten, quality number sense instruction can prevent future difficulties and concrete approaches to such instruction ensures that the students will understand the underlying concepts (Fosnot & Dolk, 2001; Furner, Yahya, & Duffy, 2005). Dienes's (1960) suggests that multiple and various types of representations aid in mathematics instruction because such representations go beyond what is expressed in speech alone and can help students connect and understand new concepts. Furthermore, manipulatives have a profound impact on how math is taught to and learned by students with disabilities (Gersten & Chard, 1999).

Uttal, Scudder, and DeLoache (1997) suggest that students learn mathematics better when they are taught using manipulatives. In addition, manipulatives help students build a foundation for learning abstract concepts and skills (Reimer & Moyer, 2005). Even more so, students who are taught using manipulatives are able to apply and transfer what they learn to new tasks as they move from concrete to semi-abstract to abstract math because they learn to visualize mathematical representations in their minds (Knap and McCrae, 1999). Unfortunately, many teachers have the tendency to move quickly from concrete mathematics instruction to the abstract level and because of this, students who are English Language Learners or who have a disability, may not be as successful in math (Sharma, 1987). However, TouchMath will keep the concrete representation and use of manipulatives constant as students move towards the abstract level.

TouchMath

TouchMath uses three modalities, visual, auditory, and kinesthetic, to teach students of all learning styles number sense, math facts, and other basic mathematic operations (Scott, 1993). TouchMath has been available for nearly thirty years and has undergone years of research, trials, and testing that suggest it is beneficial to help students in various grades with and without disabilities succeed in math. TouchMath is a multisensory method for teaching math in which manipulatives are used and math is broken down into small and logical steps without requiring the storage of arithmetic facts in memory. Since it is a silent method, it helps students with disabilities feel more comfortable in engaging in an activity that would otherwise be embarrassing for them. As students learn the TouchMath method, Calik and Kargin (2010) found that students will build skills and work on their memory of the TouchMath method to apply to addition problems.

As the demands of math skills increases, children with disabilities require additional support to acquire new knowledge, and TouchMath may be especially effective for students with mild intellectual disabilities (Calik & Kargin, 2010; Simon & Hanrahan, 2004). Calik and Kargin (2010) conducted a study with three second-grade students, ages 7-8, in inclusive classrooms. The students in the study were taught the TouchMath method for addition and subtraction over a period of time and were then given an addition and subtraction posttest which revealed not only a significant increase in comparison with pretest scores but also that those students in the study showed an average 60% increase in individual scores. (Calik & Kargin).

In another study, Simon and Hanrahan (2004) used TouchMath to evaluate the effectiveness of learning addition computational skills with three fifth-grade students with learning disabilities. In the study, the three students were examined to see if they could be taught three-row double digit addition problems using TouchMath. The results revealed that all three students exhibited a significant increase in correct responses after instruction in TouchMath, preferred this method over previously taught methods to solve addition problems and were able to retain the method for 18 weeks after completing instruction.

Summary

Previous research on using TouchMath has found it to be an effective mathematics instruction and support program for students to learn math with specific learning disabilities, mild to moderate intellectual disabilities and autism (Scott, 1993; Simon & Hanrahan, 2004; Calik & Kargin , 2010; Cihak & Foust, 2008). There are different and effective math teaching methods and curricula to be used at different grade levels. For students with disabilities, finding an effective math instruction program to meet their diverse needs is important, as a curriculum designed for general education cannot be used for special education without modifications. In general education a textbook program is often used for grades K-6 (e.g., Harcourt Math), and while this style of the delivery of math instruction may work for "typically functioning" students in general education, it may not work for students with disabilities receiving services in special education classrooms.

Although a number of studies have been done on math interventions for students with disabilities, very few deal with teaching and learning early numeracy skills in students with disabilities using TouchMath (Waters & Boon, 2011). There is a need for more research across a span of time regarding teaching math to kindergarten students with disabilities. Such research could provide insight on the acquisition of math skills in students with disabilities and in turn assist in creating stronger math learning methods and supports. Therefore, the research reviewed in this section provides sufficient support to further investigate the effectiveness of TouchMath as an effective mathematics instruction program for ELL students with disabilities in kindergarten.

CHAPTER 3

Method

Introduction

The purpose of this study was to investigate if TouchMath is effective for teaching math skills (i.e., numeracy, addition, and subtraction) to ELL kindergarten students with disabilities in the special education setting. The method, multi-baseline design and data analysis were designed to answer the research questions and to provide accurate and true results to determine if TouchMath is an effective research based strategy for teaching math to ELL kindergarten students with disabilities. After baseline data was collected for each student, each were given daily TouchMath lessons and data collection probes. Emphasis was placed on particular math skills defined as numeracy: number counting, number name , representation, and order, as well as addition and subtraction. To investigate if TouchMath was effective for teaching math skills, instruction of TouchMath was administered with ELL kindergarten participants with disabilities who were in a special day classroom. The nature of this study was experimental and required the employment of a single-subject quantitative research design. A multiple baseline across-participants design was employed. Furthermore, a curriculum based measure was used to track student's math skills. This model was designed to answer the research questions.

Setting

The elementary school used in this study was located in an urban area on the central coast of California. In particular, the school was located in an economically disadvantaged area. Many families are immigrants from Mexico, the adults work as field laborers or in packing sheds, and large families share homes. The school was located on the outer edge of this area where just a few blocks away are a golf course, a new shopping center, medical offices, and an upper middle class neighborhood. At the time of the study, the elementary school served students prekindergarten through sixth grade school and had 675 students and 29 teachers. Of the 675 students, 99% were Hispanic/Latino and 80% were ELL with a primary language of Spanish.

The classroom used in this study was a kindergarten, first and second grade class for students with disabilities. In the class, there was a visual schedule posted for the students, pictures of each student and student work were posted on a large wall above the computer area so that students could learn each other's names and see their accomplishments. Visual and simple language classroom rules and emergency procedures were posted so that students feel safe in their learning environment. Lastly, students had their own chair with their names on it, a file folder (in a crate) with their name on it for their completed work and/or for notes to the parents, and a designated backpack and coat area. There were several language support models in place including Spanish language support.

Participants

For this study, five kindergarten students with disabilities in a special education classroom participated. All were identified as English language learners. The special education teacher was female and had three years of experience teaching in a special education classroom. She is Latina and bilingual, Spanish. For the purpose of this study, each of the participants were given a pseudonym to protect their privacy and rights as stated in the following participant descriptions.

Participant 1. Maggie was 5 years of age at the time of this study. She had been identified as an ELL student and with the disabilities of Speech and Language Impairment as well as Specific Learning Disability. Maggie is a friendly and caring girl who enjoys books, art, and music. Academically, she struggles in the areas of language arts and mathematics but puts forth a lot of effort in learning all that is presented to her while in school. In language arts, Maggie can identify sounds better than she can identify the letter name which has enabled her to start reading simple three letter words and math had been her most challenging subject while in pre-school.

Participant 2. Tony was 5 years of age at the time of this study. He had been identified as an ELL student and with the disability of Deaf/Hard of Hearing. Tony is a funny and kind boy who enjoys playing with his friends, art, and singing. Academically, he is progressing very well in language arts and has great penmanship and mathematics was his favorite subject area while in pre-school.

Participant 3. Lucas was 5 years of age at the time of this study. He had been identified as an ELL student and with the disability of Autism. Lucas is a shy yet rambunctious boy who enjoys playing basketball, books, and dancing. Academically, he excels in language arts and is progressing steadily in mathematics.

Participant 4. Caleb was 5 years of age at the time of this study. He had been identified as an ELL student and with the disability of Speech and Language Impairment. Caleb is an outgoing and funny boy who enjoys puzzles, art, and books. Academically, he excels in language arts and is progressing steadily in mathematics.

Participant 5. Mark was 5 years of age at the time of this study. He had been identified as an ELL student and with the disability of Speech and Language Impairment. Mark is a kind and shy boy who enjoys skateboarding, dancing, and books. Academically, Mark struggles in language arts but has great sight word fluency. With mathematics, he struggled in preschool but progressed steadily.

Procedures

Consent and Assent. Consent for students participating in this study was obtained by sending home a written notice and consent form for permission for their child to participate in the study. The teacher provided contact information to parents for further information as needed. Then notice and consent form was sent home in both English and the parents preferred language. Assent for students participating in this study was obtained by using and reading a specially made assent form with pictures and words about the study. Students were explained what was going to happen during the research period, who was going to work with them, and that they could leave the research at any time. In addition, consent for this research was received from the Committee for the Protection of Human Subjects (CPHS) at California State University Monterey Bay.

After consent and assents were received, students participating in the study were individually assessed to obtain baseline data. Once baseline data was collected, students participated in TouchMath instruction for the intervention phase. After the TouchMath intervention phase and a final Curriculum Based Measurement (CBM) probe, students no longer participated in any of the research actions.

Materials/Instruments

The TouchMath materials used for this study are Unit 1 of the updated Kindergarten Kit (updated in 2011). The unit consists of: (1) 6 Modules with worksheets, dot notation number cards and manipulatives for the module; (2) dot notation number cards each with an individual number (for this study, the numbers will be 0-9). The number on the card has the number with the touch points on it; the dot notation number system developed by TouchMath; (3) worksheets: The worksheets are individual sheets of paper with activities that correspond with the lesson that the participants are to complete during or after a lesson; and (4) manipulatives were concrete objects that included textured dot notation number cards, Step Numerals: Individual floor mats with the dot notation numbers, 1-9, MathFans: Fans with the dot notation numbers, math concepts such as adding and subtracting, and shapes. In addition to the manipulatives used, other supportive materials such as different size pencils to support the participating student's fine motor skills, erasers, and crayons for the student to complete the worksheets were also used. Rewards (stickers) were also used to reward participants for their participation in each teaching session, CBM probe, and for the completion of their worksheets.

The CBM probes used in this study were from the website Intervention Central. For numeracy, probes from *Early Mathematics Measures* (Lembke, 2012) were used; Oral Counting (OC), Quantity Discrimination (QD), Missing Number (MN), and Number Identification (NID). Administration and scoring (with a list of materials) for each of the numeracy CBM probes were done in accordance with the *Test of Early Numeracy Administration and Scoring Manual* (Clarke & Shinn, 2002). For computation, CBM probes in the *Computation* section were used for addition and subtraction. Administration and scoring (with a list of materials) for each of the computation probes were done in accordance with the *Intervention Central Manual for Teachers* (Wright, 2008).

Interview Questions

For this study, three interview questions were asked to all of the participants on the first day of baseline data collection and on the last day of the TouchMath intervention. The purpose of the questions were to identify participant attitudes towards math and likes and dislikes about math before and after the implementation of the TouchMath intervention and changes.

The questions were:

1. Do you like math?
2. What do you like about math?
3. What do you not like about math?

Given the nature of each of the participants' identified disabilities and ELL status, the questions were also supported by using simple wording and picture cards as needed.

Baseline

During baseline, all participants received daily CBM probes which consisted of 4 assessments for numeracy, 1 for addition, and 1 for subtraction. The numeracy assessments consisted of Intervention Central CBM probes that included Oral Counting (OC) in which the student was asked to count orally, in rote, as high as they can; 40 problems for Quantity Discrimination (QD), 40 problems for Missing Number (MN), and 40 problems for Number Identification (NID). The addition and subtraction assessments consisted of two separate Intervention Central CBM probes with 30 problems for each. The participants received the assessments individually each day. The teacher scored the assessments in private and participants received a reward sticker of their choice for their participation after each session. The baseline data was collected using a multi-baseline method. Maggie was in baseline for 5 days; Tony for 8 days; Lucas for 11 days; Caleb for 14 days, and Mark for 17 days.

Intervention

Each participating student received individual TouchMath instruction during the Intervention phase. The total intervention phase was seven weeks and each student received different lengths of intervention time based on the amount of their days in baseline and any absences that occurred during the intervention phase. Maggie was in intervention for 35 days; Tony for 31 days; Lucas for 27 days; Caleb for 25 days; and Mark for 22 days. Three of the participants, Maggie, Tony, and Lucas, received daily TouchMath lessons on numeracy and computation from the TouchMath Kindergarten kit, Unit 1: Modules 1- 6 for 25 minutes daily during the math and art centers period. During the computation phase of the intervention Maggie was in intervention for 19 days; Tony for 16 days; and Lucas for 12 days. The other two participants, Caleb and Mark, received daily TouchMath lessons on numeracy and computation from the TouchMath Kindergarten kit, Unit 1: Modules 1- 4 for 25 minutes daily during the math and art centers period. The two participants who received lessons from Unit 1: Modules 1-4 did not complete the entire module due to the amount of days in baseline and the entire length of this study. The participants did not receive other mathematics instruction during this period when they rotated to another center. They continued their daily routine and participated in art activities during this period.

The teacher used a direct teaching method for each of the participants which consisted of a review of the dot notation number system at the beginning of each session, presentation and review of the lesson, modeling, teaching the lesson, presentation and review the worksheet(s), modeling the steps to complete the worksheets, and then having the participants complete the worksheets with guidance and corrective feedback. The worksheets were given a reward sticker for completion and collected in their personal math folder that was located in their cubby. The participants also received an additional sticker for their participation in each session.

Throughout each session, supportive materials (i.e., dot notation number cards and manipulative objects) were available for student use. In addition, support and prompts in using the dot notation number system were provided by the teacher throughout the entire lesson and completion of the worksheets.

Data Collection

Daily baseline data on the total amount of correct digits to numeracy problems and the addition and subtraction problems was collected from the participants after the administration of TouchMath. As part of the intervention phase, all of the participants received TouchMath instruction for various length of days: Maggie was in intervention for 35 days; Tony for 31 days; Lucas for 27 days; Caleb for 25 days; and Mark for 22 days. Each of the participants were monitored using daily Intervention Central CBM probes in the same format as the ones used in the baseline data collection period. The week following the end of the intervention, all participants were given a CBM probe posttest every 2 days.

Oral Counting (OC). The materials used for the Oral Counting probe were an Oral Counting recording sheet, pencil and clipboard for scoring, and stop watch. Student was directed to count as high as they could and that if the student did not know a number, the examiner told them the number. The examiner told the student the number only if 3 seconds had passed since saying the last number. When the examiner told the student to start, the stopwatch started and went until the student stopped counting or the stopwatch reached 90 seconds while simultaneously scoring on the Oral Counting recording sheet. For scoring, the student received correct scores for counting in sequence, repeated sequences, and self-corrections. Incorrect responses were counted if the student hesitated for longer than 3 seconds and was told the number, skipped a number, or said numbers out of sequence. The total score (of correct responses) were calculated by subtracting the total of incorrect responses from the total oral counts (the highest number or the number that the student stopped at when the stopwatch reached 90 seconds).

Number Identification (NID). The materials used for the Number Identification probe was an examiner and student copy of the Number Identification probe, pencil and clipboard for scoring, and stopwatch. The student was given a list of 10 sets of numbers with 10 numbers in each set and was asked to identify each number in each set on their copy of the probe and was told that if the student did not know the number; they could skip it and go to the next number. The examiner told the student to skip it and go to the next set only if 3 seconds had passed since answering to the last set; the student was required to answer each within 3 seconds. When the examiner told the student to start, the stopwatch started and went until the student stopped or the stopwatch reached 1 minute while simultaneously scoring on the Number Identification probe recording sheet. For scoring, if the student did not answer any correct within the first 5 items, the probe was discontinued and given a score of zero. Correct scores were counted for stating the correct number and for self-corrected responses within the 3 seconds allowed for each set. Incorrect responses were counted if the student responded with an incorrect number, did not respond within the 3 seconds, or if the student skipped a number. The total score (of correct responses) was calculated by subtracting the total of incorrect responses from the total of items attempted (100 total if done at or before 1 minute or the total that the student stopped at when the stopwatch reached 1 minute).

Missing Number (MN). The materials used for the Missing Number probe were an examiner and student copy of the Missing Number probe, pencil and clipboard for scoring, and stopwatch. The student was given 40 sets of missing number sequences and was asked to identify the missing number in the blank spot with the line (an underline) on their copy of the probe and were told that if the student did not know the number, they could skip it and go to the next set. The examiner told the student to skip it and go to the next set only if 3 seconds had passed since answering to the last set; the student was required to answer each within 3 seconds. When the examiner told the student to start, the stopwatch started and went until the student stopped or the stopwatch reached 1 minute while simultaneously scoring on the Missing Number probe recording sheet. For scoring, if the student did not answer any correct within the first 5 items, the probe was discontinued and given a score of zero. Correct scores were counted for stating the correct number and for self-corrected responses within the 3 seconds allowed for each set. Incorrect responses were counted if the student responded with an incorrect number, did not respond within the 3 seconds, or if the student skipped a set. The total score (of correct responses) was calculated by subtracting the total of incorrect responses from the total of items attempted (40 total if done at or before 1 minute or the total that the student stopped at when the stopwatch reached 1 minute).

Quantity Discrimination (QD). The materials used for the Quantity Discrimination probe were an examiner and student copy of the Quantity Discrimination probe, pencil and clipboard for scoring, and stopwatch. The student was given 40 pairs of numbers arranged in 8 rows of 5 on their copy of the probe and were directed to identify the larger number in each of the pairs and were told that if the student did not know the number, they could skip it and go to the next pair. The examiner told the student to skip it and go to the next pair only if 3 seconds had passed since answering to the last pair; the student was required to answer each within 3 seconds. When the examiner told the student to start, the stopwatch started and went until the student stopped or the stopwatch reached 1 minute while simultaneously scoring on the Quantity Discrimination probe recording sheet. For scoring, if the student did not answer any correct within the first 5 items, the probe was discontinued and given a score of zero. Correct scores were counted for responding with the bigger number within the pair and for self-corrected responses within the 3 seconds allowed for each pair. Incorrect responses were counted if the student responds with the smaller number, a number not within the pair, did not respond within the 3 seconds, or if the student skipped a pair. The total score (of correct responses) was calculated by subtracting the total of incorrect responses from the total of items attempted (40 total if done at or before 1 minute or the total that the student stopped at when the stopwatch reached 1 minute).

Addition. The materials used for the Addition probe were an addition probe, pencils, and stopwatch. The student was given 30 addition problems and was directed to solve the addition problems and write the answers for each on the probe and was told that if they do not know the answer; they could skip it and go to the next problem. When the examiner told the student to start, the stopwatch started and went until the student completed the task or the stopwatch reached 2 minutes. For scoring, correct scores were given for each individual correct digit of each problem and reversed or rotated digits (unless their position made them appear to be another number). Incorrect answers were counted if the student answered a problem incorrectly or skipped an item. The total score (of correct answers) was calculated by subtracting the total of incorrect answers from the total of items attempted (30 total if done at or before 2 minutes or the total that the student stopped at when the stopwatch reached 2 minutes).

Subtraction. The materials used for the Subtraction probe were a subtraction probe, pencils, and stopwatch. The student was given 30 subtraction problems and was directed to solve the subtraction problems and write the answers for each on the probe and was told that if they do not know the answer; they could skip it and go to the next problem. When the examiner told the student to start, the stopwatch started and went until the student completed the task or the stopwatch reached 2 minutes. For scoring, correct scores were given for each individual correct digit of each problem and reversed or rotated digits (unless their position made them appear to be another number). Incorrect answers were counted if the student answered a problem incorrectly or skipped an item. The total score (of correct answers) was calculated by subtracting the total of incorrect answers from the total of items attempted (30 total if done at or before 2 minutes or the total that the student stopped at when the stopwatch reached 2 minutes).

Data Analysis

Data collected on all five participants were scored, summarized and charted in graphic form. Graphic displays are easy to use and aid in visualizing functional relations (Kennedy, 2005). Data collected during the intervention phase can be easily compared to baseline data to show whether the intervention had an effect on the numeracy and computational (addition and subtraction) skills of each participant. In this study, one graph for each of the five participants includes baseline, intervention, and maintenance data. For each of the five participants, the graph indicates the highest number each participant counted to for the Oral Counting probe and the total amount of correct responses to numeracy and computational skills probes during the baseline data collection phase and the intervention phase. All sections of the graphs for each student were compared to examine the effectiveness of TouchMath instruction in improving math skills.

Interobserver agreement

The total amount of correct responses to numeracy questions and computational problems was calculated using CBM probes by the first observer. A second trained observer also calculated the total amount of correct responses to numeracy questions and computational problems CBM probes and co-scored 25% of the CBM probes. The scores by each of the observers for each of the CBM probes were calculated by dividing the smaller score by the larger score found for each and multiplied by 100.

Training

For the purposes of this study, one of the professional paraeducators of the classroom, in which this research took place, acted as an interobserver. The professional paraeducator was trained by the researcher in acting as an interobserver which consisted of International Review Board Human Subjects training via an online tutorial from San Diego State University and two days of training on the responsibilities and duties of an interobserver, a confidentiality agreement, and practice as an interobserver with fictional data.

Experimental Design

A single-subject research design was used for this study in order for each participants' response to intervention to be assessed. Each of participants' response to the intervention was analyzed as to whether or not experimental control over the dependent variable by the independent variable was demonstrated. A multiple baseline across participants design (Kennedy, 2005) consisting of daily 6 CBM probes after each TouchMath session during the study was used to evaluate the impact of the intervention of TouchMath.

Dependent variable and data recording. One dependent variable was selected for this study. The dependent variable was identified as correct responses to each of the CBM probes. For each probe, correct responses were recorded. The probes used in this study represent the basic math skills of counting, number identification, number value (quantity), number order, adding and subtracting.

Independent variable and intervention. The independent variable for this study is TouchMath. Instruction of lessons from Unit 1, modules 1 through 6 was administered for 25 minutes to each student. Instruction of lessons administered included direct instruction, worksheets, hands on activities using TouchMath materials, guidance, and immediate feedback.

Maintenance Probes. Three maintenance probes were administered to each of the participants every 2 days for one week after the completion of TouchMath intervention and Fall Break (9 days). The maintenance probes were administered in the same fashion as they were during baseline and intervention. The purpose of administering the maintenance probes was to determine if each of the participants have maintained the skills learned during the intervention phase.

CHAPTER 4

Results

The goal of this research was to identify an effective math curricula for kindergarten ELL students with disabilities. The purpose was to analyze the efficacy of a multisensory math curricula, TouchMath, to teach and have students learn the math skills necessary to be successful with future math learning.

Oral Counting

The Oral Counting probe required participants to count as high as they could within 90 seconds (See Figure1). The skill assessed by the Oral Counting probe was counting, in rote, as high as possible with the goal being counting to 100.

Maggie. Maggie was in the baseline phase for 5 days and in the intervention phase for 34 days. The average number Maggie could count to during baseline was 9 and during intervention, it was 53. During baseline, Maggie was able to count to 9 and by session 12 of intervention, she was able to count to 40. Nearing the end of the intervention phase, she was able to count to 80 at session 25 and was able to count to 100 at the end of her intervention phase. During the maintenance phase, she was still able to count up to 72.

Tony. Tony was in the baseline phase for 8 days and in the intervention phase for 31 days. The average number Tony could count to during baseline was 6 and during intervention, it was 29. During baseline, Tony was able to count to 9 and by session 18, he was able to count to 32. Nearing the end of the intervention phase, he was able to count to 60 at session 29 and was able to count to 70 at the end of his intervention phase. Tony was able to maintain his counting skills (counting to 70) during the maintenance phase.

Lucas. Lucas was in the baseline phase for 11 days and in the intervention phase for 28 days. The average number Lucas could count to during baseline was 15 and during intervention, it was 82. During baseline, Lucas was able to count to 20 and by session 6, he was able to count to 49. By session 11 of the intervention phase, he was able to count to 100 and was able to maintain his counting skills (counting to 100) during the maintenance phase.

Caleb. Caleb was in the baseline phase for 14 days and in the intervention phase for 25 days. The average number Caleb could count to during baseline was 22 and during intervention, it was 80. During baseline, Caleb was able to count to 20 and by session 4, he was able to count to 60. It wasn't until session 22 that Caleb was able to count to 100. However, he maintained his counting skills (counting to 100) during the maintenance phase.

Mark. Mark was in the baseline phase for 17 days and in the intervention phase for 22 days. The average number Mark could count to during baseline was 16 and during intervention, it was 83. During baseline, Mark was able to count as high as 28 and by session 4, he was able to count to 60. By session 12, Mark was able to count to 100 and was able to maintain his counting skills (counting to 100) during the maintenance phase.

Number Identification

The Number Identification probe required participants to identify as many numbers (from 0 to 9) as they could from a set of 100 within one minute (See Figure 2). The skill assessed by the Number Identification probe was correct number identification/number name.

Maggie. The average amount of numbers Maggie was able to identify during baseline was 7 and during intervention, it was 20. During baseline, Maggie was able to identify up to 9 numbers and by session 10 of intervention, she was able to identify 17 numbers. At session 25 of the intervention phase, she was able identify 26 numbers and at the end of the intervention phase, she was able to identify 33 numbers. During the maintenance phase, she was still able to identify 33 numbers.

Tony. The average amount of numbers Tony was able to identify during baseline was 14 and during intervention, it was 34. During baseline, Tony was able to identify up to 22 numbers and by session 14, he was able to identify 46 numbers. At session 26 of the intervention phase, he was able identify 50 numbers and at the end of the intervention phase, he was able to identify 54 numbers. During the maintenance phase, he was still able to identify 54 numbers.

Lucas. The average amount of numbers Lucas was able to identify during baseline was 48 and during intervention, it was 70. During baseline, Lucas was able to identify up to 61 numbers and by session 14, he was able to identify 80 numbers. At session 21 of the intervention phase, he was able identify 90 numbers and at the end of the intervention phase, he was able to identify 100 numbers. During the maintenance phase, he was still able to identify 100 numbers.

Caleb. The average amount of numbers Caleb was able to identify during baseline was 35 and during intervention, it was 64. During baseline, Caleb was able to identify up to 50 numbers and by session 16, he was able to identify 90 numbers. From then on to the end of the intervention phase as well as the maintenance phase, he was able to identify 90 numbers.

Mark. The average amount of numbers Mark was able to identify during baseline was 23 and during intervention, it was 55. During baseline, Mark was able to identify up to 27 numbers and by session 10, he was able to identify 60 numbers. At the end of the intervention phase, he was able to identify 75 numbers. During the maintenance phase, he was still able to identify up to 78 numbers.

Missing Number

The Missing Number probe required participants to identify the missing number in a number sequence using numbers from 0 to 9. There were a total of 40 sets of missing number sequences and participants were given 1 minute for the probe (See Figure 3). The skill assessed by the Missing Number probe was correct number order.

Maggie. The average score for Maggie during baseline was 0 and during intervention, it was 4. During baseline, Maggie was not able to identify the missing number in any of the number sequences. By session 5 of intervention, she was able to identify the missing number in 4 of the number sequences. Nearing the end of the intervention phase at session 30 and during maintenance, she was able to identify the missing number in 6 of the number sequences.

Tony. The average score for Tony during baseline was 0 and during intervention, it was 5. During baseline, Tony was able to identify the missing number in 1 of the number sequences. By session 5 of intervention, he was able to identify the missing number in 4 of the number sequences. At session 18 of the intervention phase and during maintenance, he was able to identify the missing number in 9 of the number sequences.

Lucas. The average score for Lucas during baseline was 1 and during intervention, it was 15. During baseline, Lucas was able to identify the missing number in 1 of the number sequences. By session 3 of intervention, he was able to identify the missing number in 10 of the number sequences. At session 9 of the intervention phase he was able to identify the missing number in 17 of the number sequences. At the end of the intervention phase and during maintenance, he was able to identify the missing number in up to 25 of the number sequences.

Caleb. The average score for Caleb during baseline was 4 and during intervention, it was 17. During baseline, Caleb was able to identify the missing number in up to 12 of the number sequences. By session 18 of intervention, he was able to identify the missing number in 20 of the number sequences. At the end of the intervention phase and during maintenance, he was able to identify the missing number in 23 of the number sequences.

Mark. The average score for Mark during baseline was 0 and during intervention, it was 6. During baseline, Mark was not able to identify the missing number in any of the number sequences. By session 2 of intervention, he was able to identify the missing number in 3 of the number sequences. At the end of the intervention phase and during maintenance, he was able to identify the missing number in 8 to 9 of the number sequences.

Quantity Discrimination

The Quantity Discrimination probe required participants to identify the larger number from a set of two numbers, from 0 to 9. There were 40 sets total and the participants were given 1 minute for the probe (See Figure 4). The skill assessed by the Quantity Discrimination probe was number value.

Maggie. The average score for Maggie during baseline was 0 and during intervention, it was 5. During baseline, Maggie was not able to identify the larger number in any of the sets. By session 13 of intervention, she was able to identify 3 of the larger numbers in the sets. At session 22 of the intervention phase, she was able identify 7 of the larger numbers in the sets and at the end of the intervention phase, she was able to identify 12 of the larger numbers. During the maintenance phase, she was able to identify up to 11 of the larger numbers in the sets.

Tony. The average score for Tony during baseline was 0 and during intervention, it was 7. During baseline, Tony was not able to identify the larger number in any of the sets. By session 22 of intervention, he was able to identify 10 of the larger numbers in the sets. At the end of the intervention phase and through the maintenance phase he was able to identify up to 10 of the larger numbers in the sets.

Lucas. The average score for Lucas during baseline was 0 and during intervention, it was 10. During baseline, Lucas was able to identify 1 of the larger numbers in the sets and at session 3 of intervention, he was able to identify 8 of the larger numbers in the sets. By session 15 of the intervention phase, he was able identify 17 of the larger numbers in the sets and at the end of the intervention phase. At the end of the intervention phase and through the maintenance phase he was able to identify up to 14 of the larger numbers in the sets.

Caleb. The average score for Caleb during baseline was 8 and during intervention, it was 18. During baseline, Caleb was able to identify up to 12 of the larger numbers in the sets and at session 9 of intervention, he was able to identify 18 of the larger numbers in the sets. By session 18 of the intervention phase, he was able identify 22 of the larger numbers in the sets and at the end of the intervention phase. At the end of the intervention phase and through the maintenance phase he was able to identify between 26 and 28 of the larger numbers in the sets.

Mark. The average score for Mark during baseline was 0 and during intervention, it was 18. During baseline, Mark was not able to identify the larger number in any of the sets and at session 3 of intervention, he was able to identify 7 of the larger numbers in the sets. By session 13 of the intervention phase, he was able identify 20 of the larger numbers in the sets and at the end of the intervention phase. At the end of the intervention phase and through the maintenance phase he was able to identify 35 of the larger numbers in the sets.

Addition

The Addition probe required participants to add two digits (from 0 – 9). There were 30 problems total and were given 2 minutes for the probe (See Figure 5). The skill assessed by the Addition probe was addition. Only three of the participants completed the addition module of the TouchMath unit.

Maggie. The average score for Maggie during baseline was 0 and during intervention, it was 1. During baseline, Maggie was not able to correctly add any of the problems but by session 22, she was able to correctly add 2 of the problems. At the end of the intervention phase and through maintenance, she was able to correctly add 4 of the problems.

Tony. The average score for Tony during baseline was 0 and during intervention, it was 1. During baseline, Tony was not able to correctly add any of the problems but by session 24, he was able to correctly add 2 of the problems. At the end of the intervention phase and through maintenance, he was able to correctly add 3 of the problems.

Lucas. The average score for Lucas during baseline was 0 and during intervention, it was 1. During baseline, Lucas was able to correctly add 2 of the problems. Through the intervention and maintenance phase, Lucas was able to correctly add up to 2 of the problems.

Subtraction

The Subtraction probe required participants to subtract two digits (from 0 – 9). There were 30 problems total and were given 2 minutes for the probe (See Figure 6). The skill assessed by the Subtraction probe was subtraction. Only three of the participants completed the subtraction module of the TouchMath unit.

Maggie. The average score for Maggie during baseline was 0 and during intervention, it was 1. During baseline, Maggie was not able to correctly subtract any of the problems but by the end of the intervention phase and through maintenance, she was able to correctly subtract up to 3 of the problems.

Tony. The average score for Tony during baseline was 0 and during intervention, it was 1. During baseline, Tony was not able to correctly subtract any of the problems but by the end of the intervention phase and through maintenance, he was able to correctly subtract 1 of the problems.

Lucas. The average score for Lucas during baseline was 0 and during intervention, it was 1. During baseline, Lucas was not able to correctly subtract any of the problems but by the end of the intervention phase and through maintenance, he was able to correctly subtract 1 of the problems.

Interview Questions

Prior to and after the intervention phase of this study, all participants were asked three questions.

Question 1. The first question asked to the participants was, Do you like math? Prior to the intervention, 3 of the participants answered yes and 2 answered no. After the intervention, all participants stated that they like math.

Question 2. The second question asked to the participants was, What do you like about math? Prior to the intervention, counting and writing numbers were the common answers for this question with some participants adding that they like to color as a part of math. After the intervention, the common answers were also counting, writing, and coloring.

Question 3. The third question asked to the participants was, What do you not like about math? Prior the intervention, answers to this question varied with some participants stating that they do not like to write the numbers or count. After the intervention, the participants stated that they there wasn't anything they disliked about math but that some things like subtraction were "tricky".

Summary

The data collected shows that all five participants increased their skills in oral counting, number identification, number order, and number quantity discrimination. The three participants that completed the addition and subtraction modules increased their skills in addition and subtraction.

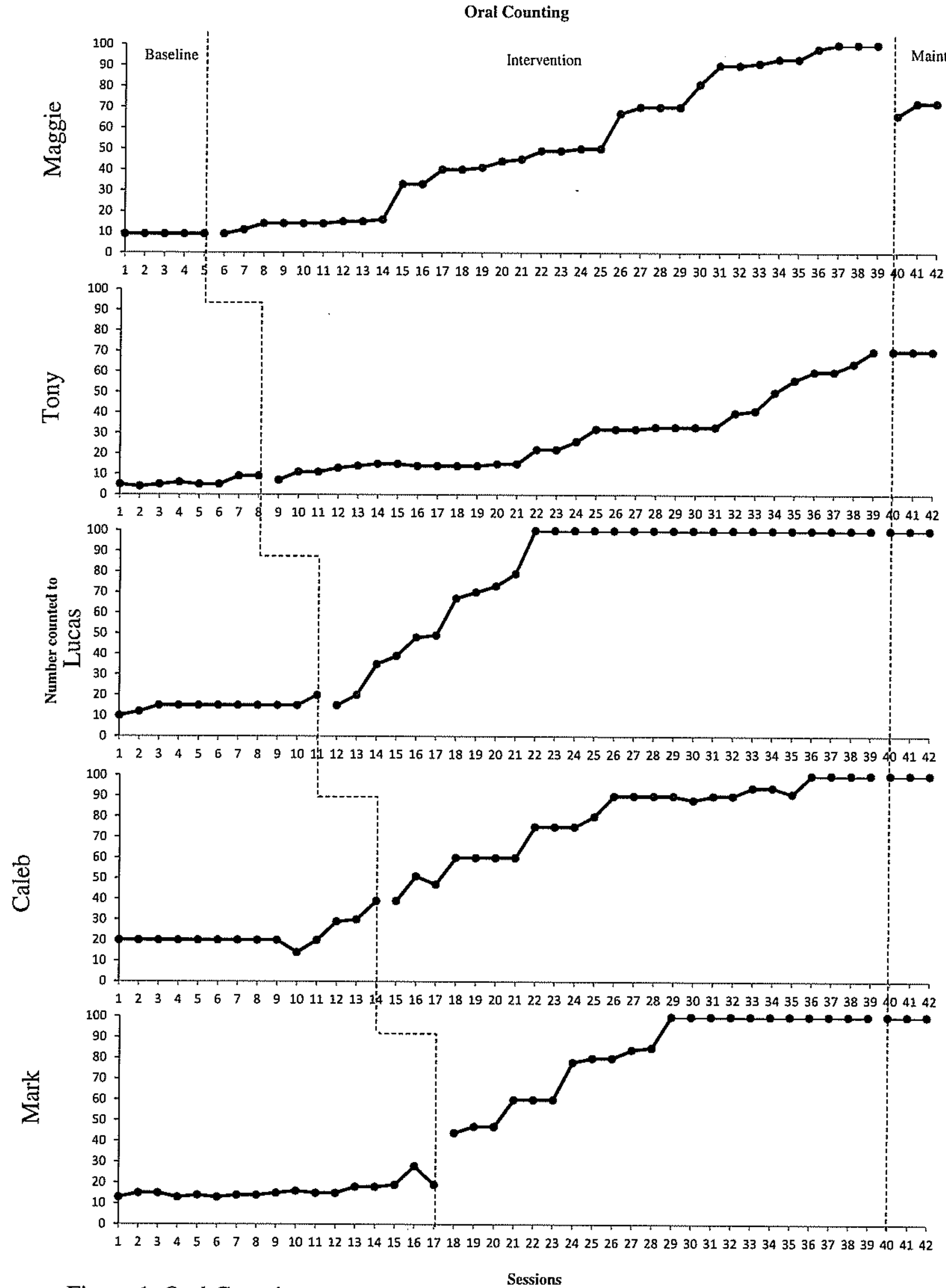

Figure 1. Oral Counting

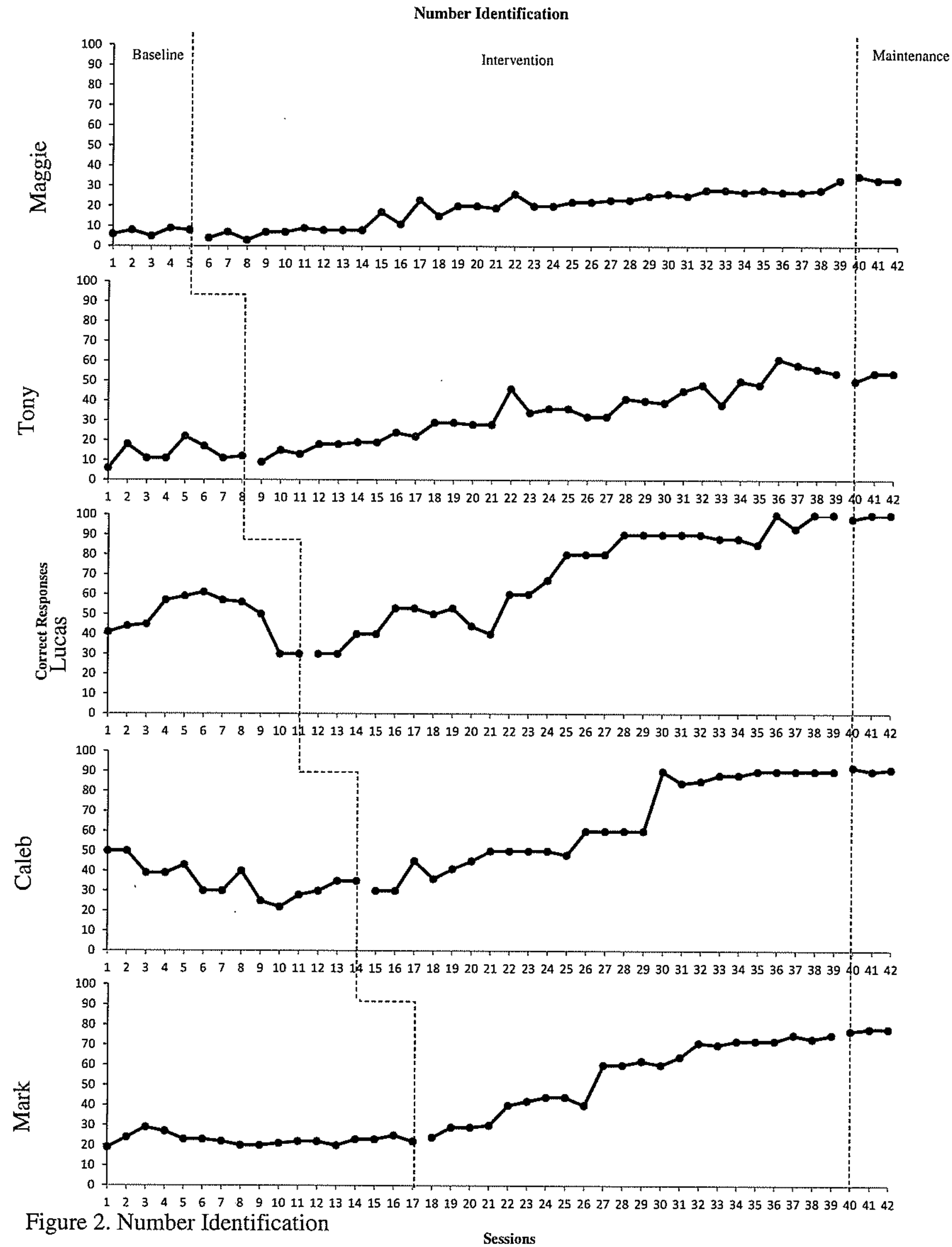

Figure 2. Number Identification

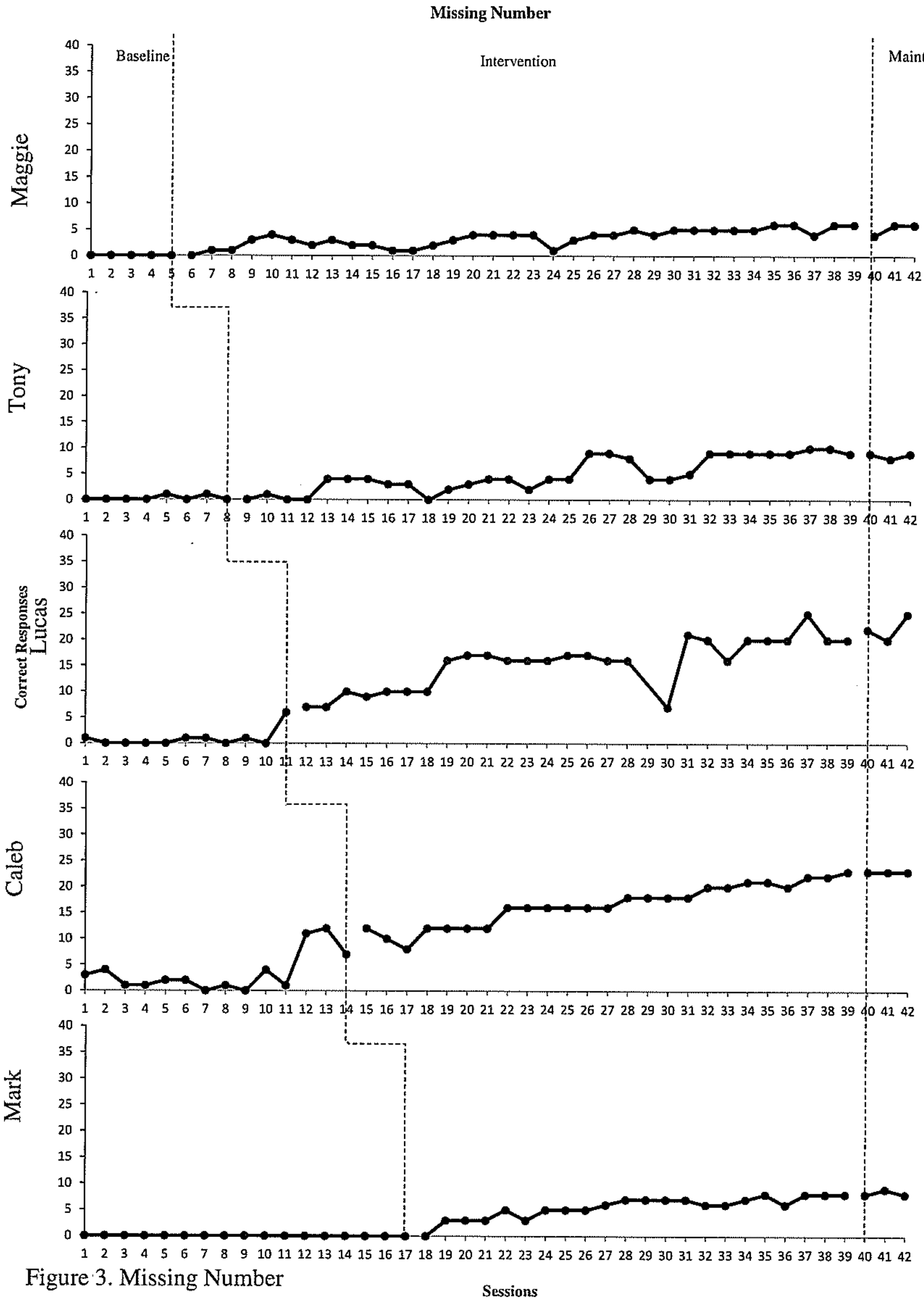

Figure 3. Missing Number

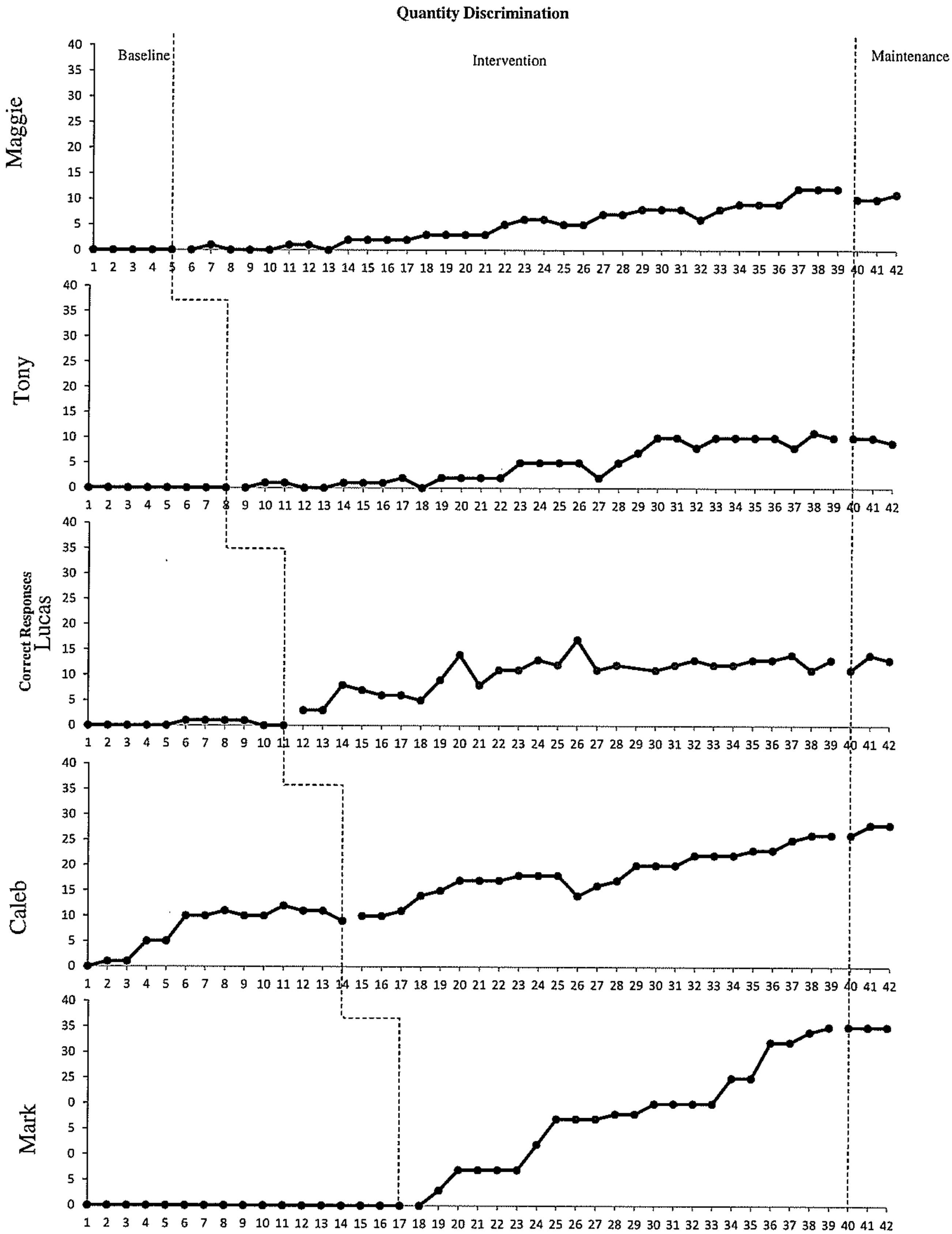

Figure 4. Quantity Discrimination

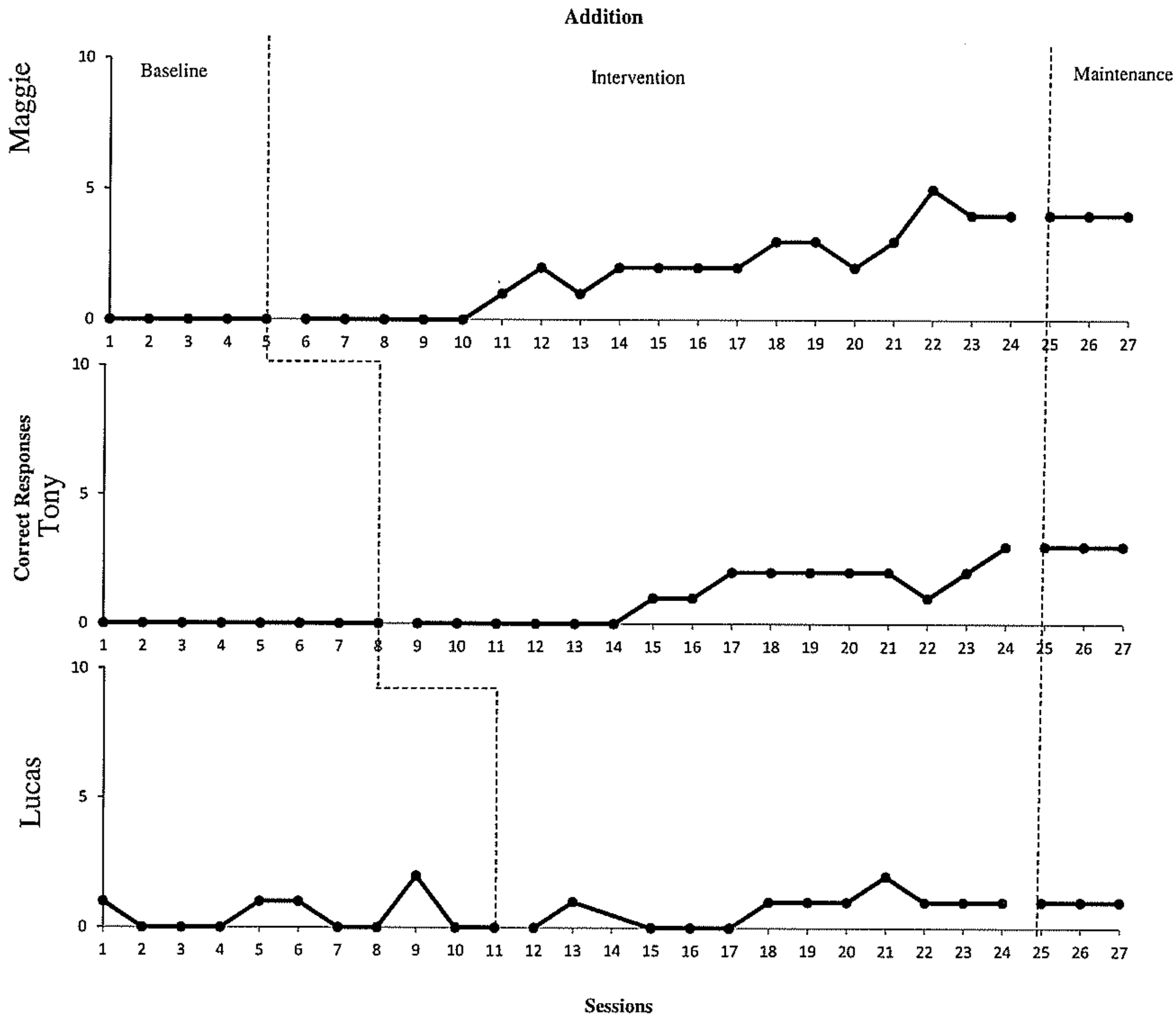

Figure 5. Addition

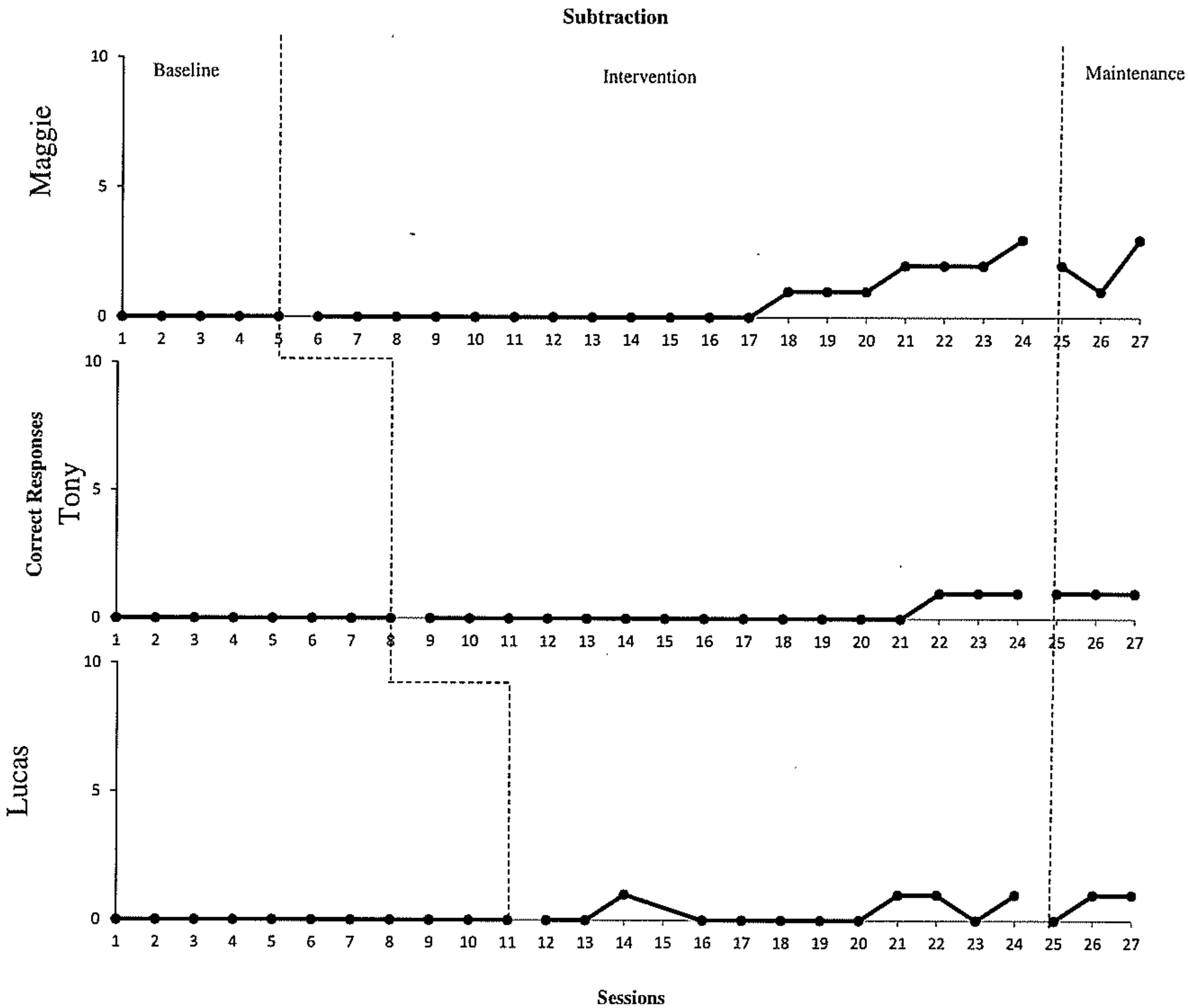

Figure 6. Subtraction

CHAPTER 5

Discussion

To evaluate the effectiveness of TouchMath for kindergarten ELL students with mild to moderate disabilities, a multiple baseline across participants design examined whether a multi-sensory approach would increase math skills; where the number of correct responses in math probes increased and a change in interview questions answers would change positively. After analyzing the data, all participants increased their number of correct responses in oral counting, number identification, missing number, and quantity discrimination. The three participants who participated in the addition and subtraction interventions also increased their number of correct responses.

Oral counting. All of the participants had some oral counting skills during baseline. After entering the intervention phase, each student began to increase their oral counting skills. Maggie and Tony were the first two students in intervention but took more time in acquiring oral counting skills. This can be attributed to being an ELL student; where learning the numbers in English was a challenge for them. The students that made steady progress in oral counting skills could possibly be attributed to having more English exposure at home. It could be concluded that the rate in which students acquire (English) oral counting skills is related to their exposure to English and math skills prior to kindergarten. Additionally, math instruction could be viewed as an English language development tool for ELL students

Number identification. All of the participants had some number identification skills during baseline. However, their fluency rate, where the ability to identify numbers more quickly is shown, increased. This can be attributed to the use of the TouchMath worksheets because the worksheets were presented by number and a great deal of time was spent on number name (identification) and number value. Additionally, the presentation of the worksheets was sequential which could also be why students were able to increase their oral counting skills, number sequence (as shown in the Missing Number probe) and their number value skills (as shown in Quantity Discrimination probe). Again, the participants were using language developments skills and were able to make connections between the number name and what it looks like.

Missing number. Maggie, Tony, Lucas, and Mark had none or little number sequence skills. After entering intervention, they increased their number sequence skills. Caleb, however, had some number sequence skills during baseline. There is no explanation for this other than previous exposure while in preschool and that he was able to maintain those skills when he entered kindergarten and was able to increase his number sequence skills during intervention. This skill, in particular, is a skill that had the participants combine oral counting and number identification skills; as they acquired those two skills, their number sequencing skills also improved.

Quantity discrimination. All of the participants made significant progress with the number value skill after entering intervention. It can be concluded that the manipulatives and worksheets helped the participants in learning the skills because the manipulatives aided the participants in representing each number and the worksheets provided semi-concrete and abstract representations of the number; the participants were able to connect concrete and abstract math skills.

Addition. The introduction of the addition module came late in the intervention phase. Maggie and Tony had no skills in addition during baseline but they quickly learned addition skills when introduced in the intervention phase. Lucas, however, showed some skills in addition during baseline. This could be attributed to previous exposure to addition skills while in preschool. Lucas did increase his addition skills during intervention. Similar to acquiring the other skills, the participants quickly learned addition skills because of the use of manipulatives along with the worksheets.

Subtraction. As with addition, the subtraction module came late in the intervention phase. None of the participants had any subtraction skills but once they entered the subtraction module, they quickly learned subtraction skills and increased their skills in intervention. Again, participants quickly learned subtraction skills because of the use of manipulatives along with the worksheets.

Interview questions. On the first day of baseline data collection and on the last day of the intervention phase, all of the participants were asked three interview questions. Baseline responses to the question were not as cheerful and positive as the answers at the end of the intervention phase. The positive changes in responses can be attributed to the multisensory learning method that is present in TouchMath. It was observed throughout the intervention phase that the participants enjoyed learning and were enthusiastic about participating in their TouchMath sessions.

Multisensory learning. The participants all used the TouchMath and additional supportive materials throughout the intervention phase. It was observed that all of the participants enjoyed learning math and that can be attributed to the TouchMath program in its entirety and the other supportive multisensory materials. This can be credited as a reason why there was an increase in math skills and positive changes in responses to the interview questions.

English language development. All of the participants were identified as ELL students and there was an observed increase in their English language skills while participating in this study. While the development of English language skills cannot be entirely attributed to TouchMath, research does show that the use of multisensory learning plays a role in language development (Brice & Roseberry-McKibbin, 1999; Langdon, 1996).

Summary

The significant increase in the average number of correct responses, from baseline to intervention, for all participants represents the numeracy skills learned from TouchMath. Using TouchMath and its multisensory approach, participants were able to learn to count to a higher number, identify numbers accurately, identify correct number sequences, and determine correct number quantity. The increase in the average number of correct responses, from baseline to intervention, for the three participants who participated in the addition and subtraction interventions represent computational skills learned using TouchMath.

With the increase in the number of correct responses for all participants, it is evident that using TouchMath and its multisensory approach is effective in teaching numeracy skills and computational skills (i.e. addition and subtraction) to ELL kindergarten students with mild to moderate disabilities. The TouchMath program, in its entirety, allows for students to learn both math and English language skills through multiple modalities and teaches students skills that can be maintained throughout the school year.

Limitations and Implications for Future Research

This study had the limitations of the length of time of the entire research study and the small size of the total number of participants in the study. The total length of time for this study was nine weeks and had five participants, both of which can affect the external validity and generalization of the findings to a wider population.

The data from this research suggests a number of different possibilities for future research. A study that includes a larger sample size as well as a study that includes students of different age categories would allow for generalization to other students. Similarly, a study done for a longer period of time that also includes a longer maintenance period would allow for researchers to determine if the skills learned in TouchMath can be retained for a longer period. Additionally, a study that includes students whose first language is not Spanish (i.e. Tagalog and Vietnamese) would also be helpful in determining if TouchMath is appropriate for other ELL students. Lastly, the data from this research could provide a foundation for researchers to continue investigating TouchMath and other multisensory programs as a strategy in teaching academic skills to ELL students with disabilities.

Implications for Practice

The results from this study further support the use of more multisensory strategies in classrooms to teach students academic skills as well as to support the development and needs of the ELL students. This study allowed the participants to learn math skills that can be maintained and because of this, using TouchMath regularly throughout the school year will help students become successful in mathematics and language development.

Making this research available, through presentations and electronic postings, will help teachers of ELL students with disabilities use the results of this study to determine if they would like to use TouchMath as an effective strategy to teach math skills in their classroom. Additionally, the positive results of using this multisensory approach will allow for teachers to determine if they would like to pursue using other multisensory programs in their classrooms as well. Lastly, this research could support the availability of TouchMath and other multisensory programs and materials in school districts.

Conclusion

The results of this study showed significant increases in the number of correct responses to the probes administered to each participant. Increases in the average number of correct responses to numeracy probes significantly improved from baseline to intervention. This provides information that there was an increase in the numeracy skills learned for all participants. The participants who took part in the addition and subtraction interventions were able to quickly learn basic computational skills and this is evident in the average number of correct responses in the intervention period.

This research found that using a multisensory approach, TouchMath, is effective in teaching math skills to ELL kindergarten students with disabilities. While the length of this study was short, it is still evident that TouchMath can be effective for students to learn math skills. Additionally, the use of TouchMath helped students in increasing their English language skills. While this was not measured, it was observed, and confirmed previous research, that multisensory teaching and learning positively benefits ELL students in learning English.

In closing, this study answered the research questions asked for this study and, based on the results of this study, it is with great confidence to continue using TouchMath and other multisensory strategies to teach students math skills and support their English language development needs. This research can help in creating a foundation for other teachers and professionals who are seeking multisensory research-based strategies for teaching their students math and to aide in English language development.

References

Arnheim, D. D., & Sinclair, W. A. (1975). *The clumsy child.* St. Louis, MO: Mosby.

August, D. & Hakuta, K. (Eds). (1998). *Improving schooling for language-minority children.* Washington, DC: National Academy Press.

Avant, M., & Heller, K. (2011). Examining the effectiveness of TouchMath with students with physical disabilities. *Remedial And Special Education, 32*(4), 309-321.

Ayres, A. J. (1972). *Sensory integration and learning disorders.* Los Angeles: Western Psychological Services.

Battista, M. T. (1999). The Mathematical miseducation of America's youth: Ignoring research and scientific study in education. *Phi Delta Kappan, 80*(6), 424-33.

Biggs, J. B., & Collis, K. F. (1991). Multimodal learning and the quality of intelligent behaviour. *Intelligence: Reconceptualization and measurement*, 57-76.

Brice, A. (1999). Turning frustration into success for English language learners. *Educational Leadership, 56*(7), 53.

Bullock, J., Pierce, S., McClelland, L. (1989). *TouchMath Manual.* Colorado Springs, CO: Innovative Learning Concepts, Inc.

California State Board of Education (1999). *Mathematics Framework for California Public Schools: Kindergarten through grade twelve.* Sacramento: California Department of Education.

Calik, N. & Kargin, T. (2010). Effectiveness of the touch math technique in teaching addition skills to students with intellectual disabilities. *International Journal of Special Education, 25*, 195-204.

Chard, D. J., Baker, S. K., Clarke, B., Jungjohann, K., Davis, K., & Smolkowski, K. (2008). Preventing early mathematics difficulties: The feasibility of a rigorous kindergarten mathematics curriculum. *Learning Disability Quarterly, 31* (1), 11-20.

Chard, D. J., Clarke, B., Baker, S., Otterstedt, J., Braun, D., & Katz, R. (2005). Using measures of number sense to screen for difficulties in mathematics: Preliminary findings. *Assessment for Effective Intervention*, *30* (2), 3-14.

Cihak, D. F., & Foust, J. L. (2008). Comparing number lines and touch points to teach addition facts to students with autism. *Focus On Autism & Other Developmental Disabilities*, *23*(3), 131-137.

Clarke, B., & Shinn, M. R. (2004). A preliminary investigation into the identification and development of early mathematics curriculum-based measurement. *School Psychology Review*, *33*(2), 234-248

Clarke, B., & Shinn, M.R. (2002). Test of Early Numeracy Administration and Scoring Manual. Retrieved from http://www.interventioncentral.org/cbm_warehouse#8.

Clements, D.H. & Sarama, J.H. (2008). Experimental evaluation of the effects of a research based preschool mathematics curriculum. *American Educational Research Journal, 45* (2), 443-494

Clements, D.H., Sarama, J.H., & Liu, X.H. (2008). Development of a measure of early mathematics achievement using the Rasch Model: The research-based early maths assessment. *Educational Psychology, 28*(4), 457 – 482.

Cratty, Bryant J. (1964). *Movement behavior and motor learning.* Philadelphia: Lea & Febiger.

Dale, T.C. & Cuevas, G.J. (1992). Integrating mathematics and language learning. In P.A. Richard- Amato & M.A. Snow (Eds), *The multicultural classroom: Readings for content-area teachers.* White Plains, NY: Longman.

Daly, E., & McCurdy, M. (2002). Getting it right so they can get it right: An overview of the special series. *School Psychology Review, 31*(4), 453-458.

Dienes, Z. P. (1960). *Building up mathematics.* New York: Hutchison Educational.

Durmus, S., & Karakirik, E. (2006). Virtual manipulatives in mathematics education: a theoretical framework. *The Turkish Online Journal of Educational Technology 5(1),* Article 12.

Fosnot, C., & Dolk, M. (2001). *Young Mathematicians at Work: Constructing Number Sense, Addition, and Subtraction.* Westport, CT: Heinemann Publishing.

Frostig, M. (1972). Visual perception, integrative functions and academic learning. *Journal of learning disabilities, 5*(1), 5-19.

Funkhouser, C. (1995). Developing number sense and basic computational skills in students with special needs. *School Science And Mathematics, 95*(5), 236-39.

Furner, J.M., Yaha, N., & Duffy, M. (2005). Teach mathematics: Strategies to reach all students. *Intervention in School and Clinic, 41*(1), 16-23.

Gersten, R., & Chard, D. (1999). Numbersense: Rethinking arithmetic instruction for students with mathematical disabilities. *Journal of Special Education 33(1),* 18-28.

Grafman, J. M., & Cates, G. L. (2010). The differential effects of two self-managed math instruction procedure: Cover, copy, and compare versus copy, cover, and compare. *Psychology In The Schools, 47*(2), 153-165.

Gutiérrez, R. (2002). Beyond Essentialism: The complexity of language in teaching mathematics to Latina/o students. *American Educational Research Journal, 39*(4), 1047-1088.

Hannaford, C. (1995). *Smart moves.* Arlington, VA: Great Ocean.

Heuser, D. 2000. Mathematics class becomes learner centered. *Teaching Children Mathematics* 6(5): 288-95.

Hoover, J. J., & Patton, J. R. (2005). Differentiating curriculum and instruction for English-language learners with special needs. *Intervention In School & Clinic, 40*(4), 231-235.

Kavale, K., & Mattson, P. D. (1983). "One jumped off the balance beam" Meta-analysis of perceptual-motor training. *Journal of learning disabilities, 16*(3), 165-173.

Kennedy, C.H. (2005). *Single-case design for educational research.* Boston, MA: Allyn & Bacon.

Kephart, N. C. (1960). *The slow learner in the classroom* (1st ed.). Columbus, OH: Merrill.

Kephart, N. C. (1960). *The slow learner in the classroom* (2nd ed.). Columbus, OH: Merrill.

Knapp, B. & McCrae, D., (1999). *Math Matters.* Danbury, CT: Grolier Educational Corporation.

Kurtz, R (1978). Kindergarten mathematics: A survey. *Arithmetic Teacher 26*, 51-52.

Langdon, H. W. (1996). English language learning by immigrant Spanish speakers: A United States perspective. *Topics In Language Disorders, 16*(4), 38-53.

Lembke, Erica. (n.d.). Early math fluency generator CBM probes: *numberfly.* Retrieved from http://www.interventioncentral.org/tools/early-math-fluency-generator.

McCallum, E., Skinner, C. H., & Hutchins, H. (2004). The taped-problems Intervention: Increasing division fact fluency using a low-tech self-managed time-delay intervention. *Journal Of Applied School Psychology, 20*(2), 129-147.

Mulligan, J., Mitchelmore, M., & Prescott, A. (2005). Case studies of children's development of structure in early mathematics: A two-year longitudinal study. *Mathematics Education Research Journal.* 2009, *21*(2), 33-49

National Council of Teachers of Mathematics, I. A. (2006). *Curriculum Focal Points for prekindergarten through grade 8 mathematics: A quest for coherence.* National Council of Teachers of Mathematics. Retrieved from http://www.nctm.org/news/content.aspx?id=27276

Nicely, R., Fiber, H., & Bobango, J. (1986). The cognitive content of elementary school mathematics textbooks. *Arithmetic Teacher 34*, 60-61

Olkun, S. (2003). Comparing computer versus concrete manipulatives in learning 2D geometry. *Journal Of Computers In Mathematics And Science Teaching*, *22*(1), 43-56.

Ortiz, A. & Wilkinson, C. (1991). Assessment and intervention model for the bilingual exceptional student. *Teacher Education and Special Education, 14,* 35-42.

Ortiz, A. (1997). Learning disabilities occurring concomitantly with linguistic differences. *Journal of Learning Disabilities, 30.* 321-332.

Poncy, B., Skinner, C., & Jaspers, K. (2007). Evaluating and comparing interventions designed to enhance math fact accuracy and fluency: Cover, copy, and compare versus taped problems. *Journal Of Behavioral Education*, *16*(1), 27-37.

Reimer, K., & Moyer, P. S. (2005). Third-graders learn about fractions using virtual manipulates: A classroom study. *Journal Of Computers In Mathematics And Science Teaching*, *24*(1), 5-25.

Rhymer, K. N., Dittmer, K. I., Skinner, C. H., & Jackson, B. (2000). Effectiveness of a multi-component treatment for improving mathematics fluency. *School Psychology Quarterly, 15*(1), 40-51.

Scott, K. S. (1993). Reflections on "Multisensory mathematics for children with mild disabilities." *Exceptionality: A Research Journal, 4*(2), 125-29.

Sharma, M. (1987). How to take a child from concrete to abstract. *Math notebook.* ERIC Documentation Reproduction Service No. ED 342600.

Simon, R. & Hanrahan, J. (2004). An evaluation of the touch math method for teaching addition to students with learning disabilities in mathematics. *European Journal of Special Needs Children, 19*(2), 192-209.

Skinner, C. H., McLaughlin, T. F., & Logan, P. (1997). Cover, copy, and compare: A self-managed academic intervention effective across skills, students, and settings. *Journal Of Behavioral Education, 7*(3), 295-306.

Thornton, C., Jones, G. & Toohey, M. (1983) A multisensory approach to thinking strategies for remedial instruction in basic addition facts. *Journal for Research in Mathematics Education, 14*, 198–203.

U.S. Department of Education. (2007). *No Child Left Behind of 2001*. Retrieved from http://www.ed.gov/nclb

Uttal, D. H., Scudder, K. V., & DeLoache, J. S. (1997). Manipulatives as symbols: A new perspective on the use of concrete objects to teach mathematics. *Journal Of Applied Developmental Psychology, 18*(1), 37-54.

Van Luit, J. & Schopman, E. (2000). Improving early numeracy of young children with special education needs. *Remedial and Special Education, 21,* 27-40.

Waters, H. E., & Boon, R. T. (2011). Teaching money computation skills to high school students with mild intellectual disabilities via the touchmath© program: A multi-sensory approach. *Education and Training in Autism and Developmental Disabilities, 46*(4), 544.

Wright, J. (2008). *Intervention central manual for teachers.* Retrieved from http://www.interventioncentral.org/cbm_warehouse#8.

Youssefi, P. & Youssefi, A. (2000). Sensory-motor integration: A perceptual-motor approach for enhancing motor planning in children with special needs. *Clinical practice guidelines: Redefining the standards of care for infants, children, and families with special needs* (537- 557). Bethesda, Maryland: The Interdisciplinary Council on Developmental & Learning Disorders

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Committee for the Protection of Human Subjects, CSUMB
CONSENT TO PARTICIPATE IN RESEARCH

Title of Project: Using TouchMath to increase math skills for young English Language learners with disabilities

Hello, My name is Anamaria Covarrubias. I am your child's teacher at Virginia Rocca Barton School and a student of the Special Education Program at California State University, Monterey Bay. I would like your child to participate in a research study I am conducting to be used to determine the effectiveness of TouchMath in teaching math to children with disabilities who are English language learners.

The purpose of this research is to determine the effectiveness of TouchMath in teaching math to children with disabilities who are English language learners. An additional purpose of this research is to provide teachers with another way to teach math to young children.

Your child was selected as a participant in this study because they are receiving special education services and have a primary language of Spanish.

Any information that is obtained in connection with this study and that can be identified with your child will remain confidential and will only be disclosed with your written or witnessed verbal permission or as required by law. Your child's name will not appear in this study; It will be changed to keep your child anonymous.

Allowing your child to participate in this study is entirely up to you. You can choose whether or not your child be in the study. If you allow your child to participate in this study, you may withdraw your child at any time without consequences of any kind.

If you decide to give permission for your child participate in this research, your child will continue to attend school as scheduled, will receive all academic instruction as planned and will continue to receive all services. For this study, your child will receive one-to-one math instruction using TouchMath during the math period. Again, everything else will remain the same and this will not affect your child's services and eligibility.

If you want to know more about this research project or have questions or concerns, please contact me, (831) 753-5770 or email me at acovarrubias@csumb.edu.

The project has been reviewed and accepted by California State University, Monterey Bay. You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have questions about CSUMB's rules for research, please call the Committee for Human Subjects Chair, Chip Lenno, CSUMB Technology Support Services, 100 Campus Center, Building. 43, Seaside CA 93955, 831.582.4799.

Appendix A

California State University
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You will get a copy of this consent form. Thank you for considering participation.

Sincerely,

Anamaria Covarrubias
Teacher, Virginia Rocca Barton School
CSUMB Master of Arts in Education/Special Education Program

Consent Statement

I understand the procedures described. My questions have been answered to my satisfaction and I freely agree to allow my child to participate in this study. I know what my child will have to do and that I can withdraw my child at any time.

I have been given a copy of this Consent Form.

Signature ________________________ Date ____________

Signature of Researcher

In my judgment, the parent of the participant is voluntarily and knowingly giving informed consent and possesses the legal capacity to give informed consent to participate in this research study.

Signature of Researcher ________________________ Date ____________

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Comité para la Protección de Sujetos Humanos CSUMB
CONSENTIMIENTO PARA PARTICIPAR EN UN ESTUDIO

Título del Proyecto: Utilización de TouchMath para mejorar las habilidad matemática de los jóvenes aprendices de inglés con necesidades especiales.

Hola, me llamo Anamaria Covarrubias. Soy la maestra de su hijo/a en la escuela Virginia Rocca Barton y participo en el Programa de Educación Especial de la Universidad Estatal de California de Monterey Bay. Me gustaría que su hijo participara en un estudio de investigación que estoy llevando a cabo para determinar la efectividad de TouchMath en la enseñanza de las matemáticas a niños con necesidades especiales que están aprendiendo inglés.

El propósito de esta investigación es determinar la efectividad de TouchMath en la enseñanza de las matemáticas a niños con necesidades especiales que están aprendiendo inglés. Además, este estudio proporcionará a los maestros otras herramientas para impartir matemáticas a niños de corta edad.
Su hijo ha sido seleccionado para participar en el estudio porque recibe servicios de educación especial y porque su lengua materna es el español.

Cualquier información que pueda ser obtenida en relación con este estudio y que pueda implicar a su hijo/a será confidencial y sólo podría ser revelada con su permiso por escrito, verbalmente en el caso de que hubiera testigos, o como lo estipule la ley. El nombre de su hijo/a no aparecerá en el estudio, sino que será modificado para mantener su total anonimato.

La participación de su hijo/a depende exclusivamente de usted. Usted elegirá si pasará a formar parte de él o no. Si acepta que su hijo colabore, podrá renunciar en cualquier momento a que su hijo/a continúe en el proyecto sin ninguna consecuencia.

Si decide dar su consentimiento, su hijo/a continuará asistiendo con normalidad a la escuela, recibirá toda la instrucción y los servicios que acostumbra. Para este estudio el estudiante recibirá instrucción directa con el maestro y con TouchMath durante el periodo de matemáticas. Nuevamente, todo lo demás se mantendrá igual y no afectará a los servicios que su hijo/a reciba y otros servicios para los que califique.

Si desea saber más sobre este proyecto de investigación o tiene otras dudas, le ruego se ponga en contacto conmigo en el número (831) 753-5770, así como a través de mi correo electrónico acovarrubias@csumb.edu o llame a Dr. Cathi Draper Rodríguez en 831.582.3652.

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Este proyecto ha sido revisado y aprobado por la Universidad Estatal de California de Monterey Bay. Usted puede renunciar a dar su consentimiento en cualquier momento sin ningún tipo de sanción. No está rechazando ningún derecho legal por su participación en este estudio de investigación. Si tiene alguna pregunta sobre la normativa de investigación de la Universidad Estatal de California de Monterey Bay, le rogamos contacte por teléfono con el Jefe del Comité de Asuntos Humanos, Chip Lenno, los Servicios de de Soporte Tecnológico, 100 Campus Center, Edificio 43. 43, Seaside CA 93955, 831.582.4799.

Obtendrá una copia de este consentimiento. Gracias de antemano por considerar participar en este proyecto.

Atentamente,

Anamaria Covarrubias
Maestra, Escuela Virginia Rocca Barton
CSUMB Maestría de Educación/ Programa de Educación Especial

Declaración de consentimiento

Entiendo el procedimiento anteriormente descrito. Mis preguntas o dudas han sido resueltas satisfactoriamente y acepto libremente que mi hijo/a participe en este estudio. Sé lo que mi hijo/a tendrá que hacer y que puedo decidir que deje de participar en el estudio en cualquier momento.

He recibido una copia de este formulario de consentimiento.

________________________________ __________________
Firma Fecha

Firma del Investigador

A mi juicio, el padre o tutor del participante ha sido informado diligentemente y posee la capacidad legal de dar su consentimiento para formar parte del estudio de investigación de forma voluntaria.

________________________________ __________________
Firma del Investigador Fecha

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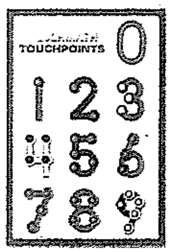
PARTICIPANT INFORMATION STATEMENT AND ASSENT SCRIPT

Using TouchMath to increase math skills for young English Language learners with disabilities

Participant selection and purpose of study

You have been invited to be part of a study. The researcher (your teacher),

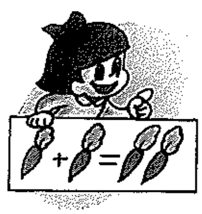
would like to find out if using TouchMath



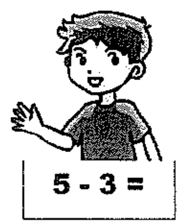
will help you learn

Counting

Adding



and Subtracting

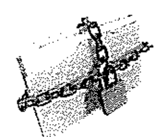


Description of study and risks

If you say yes to be in the study, you will come to class every day as always, and you will do TouchMath with Miss Ana. In addition, you will take some tests with me.

Confidentiality and disclosure of information

The researchers will write about the study, but won't use your name.



No one reading about the study will know who you are or see any of your personal information.

If you have any questions, or decide you don't want to be in the study anymore, it is okay, just tell me and you can stop whenever you want.

Appendix B

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If you have any questions, or decide you don't want to be in the study anymore, it is okay, just tell me and you can stop whenever you want.

....
Signature of Research Participant

....
(Please PRINT name) Signature of Witness

....
(Please PRINT name)

....
Date Nature of Witness

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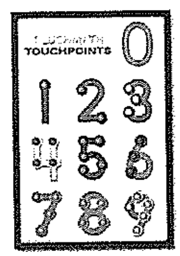
DECLARACIÓN DE INFORMACIÓN PARA EL PARTICIPANTE Y GUIÓN DE APROBACIÓN

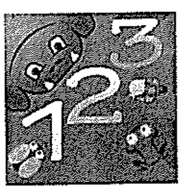
Uso de TouchMath para mejorar la habilidad matemática en jóvenes aprendices de inglés con necesidades especiales

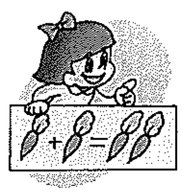
Selección de participante y objeto de estudio

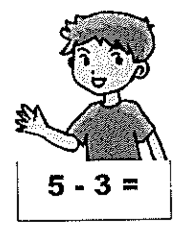
Has sido elegido para formar parte de un estudio. La investigadora (tu maestra).

Ana Covarrubias (Miss Ana)  querría saber si usar TouchMath 

te ayudará a

aprender a Contar 

Sumar 

y Restar 

Descripción de estudio y riesgos

Si aceptas participar en el estudio, vendrás a clase como cada día, y harás TouchMath con Miss Ana. También harás algunos exámenes conmigo.

Confidencialidad y revelación de información

Los investigadores escribirán sobre el estudio pero no dirán tu nombre.

Ninguna de las personas que lean el estudio sabrán quién eres o verán tu información personal.

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Si tienes alguna pregunta o decides que ya no quieres estar en el estudio, está bien. Sólo tienes que decírmelo y podrás parar en cualquier momento.

....

Firma del Participante del Estudio

....

(Nombre en LETRA) Firma del testigo

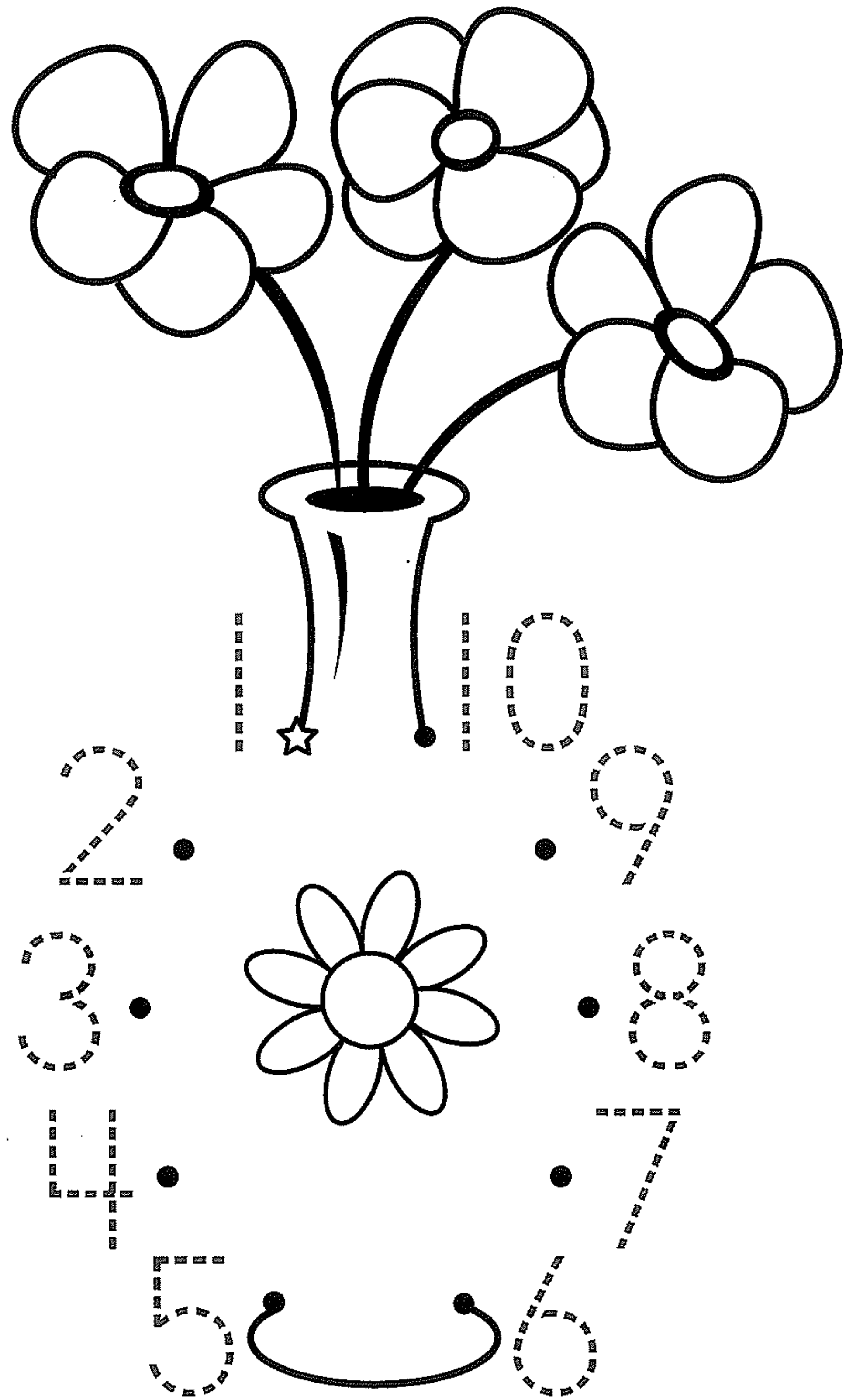
....

(Nombre en LETRA)

....

Fecha Naturaleza del Testigo

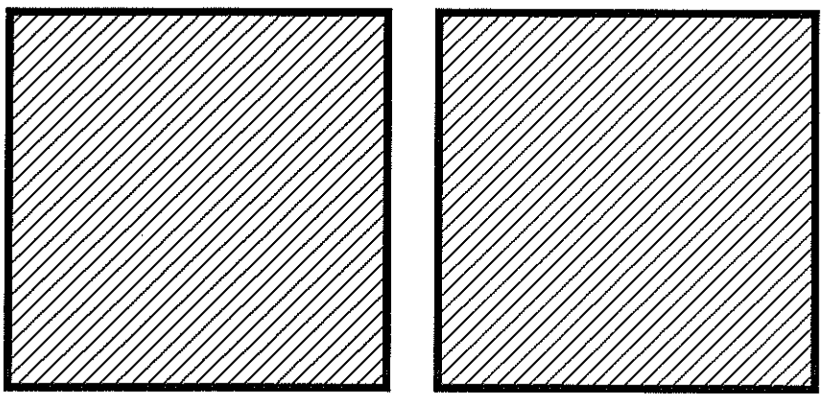
Name ________________________________



Appendix C

Name ________________________________

0 1 2 3 4 5



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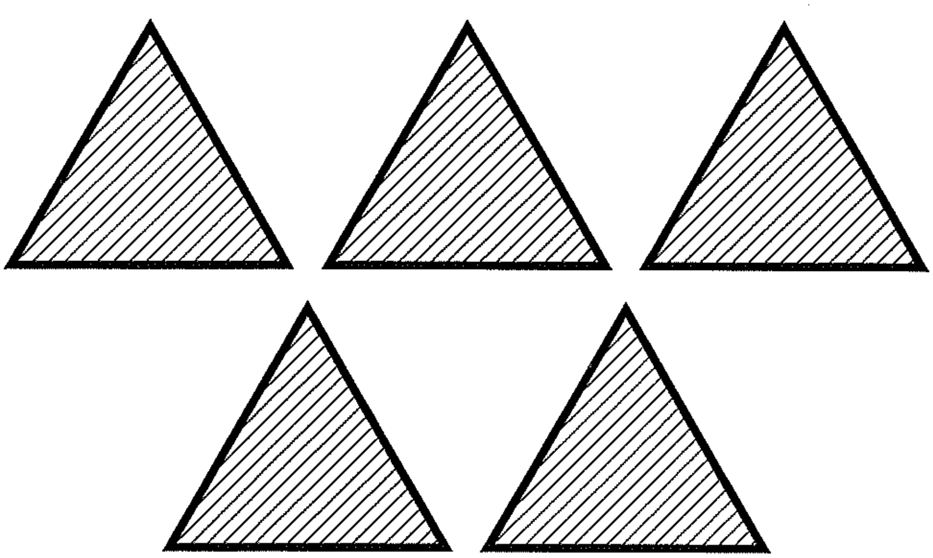


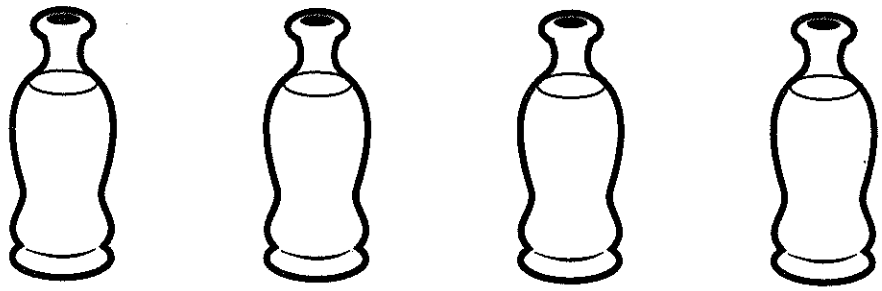
○ 4

○ 5

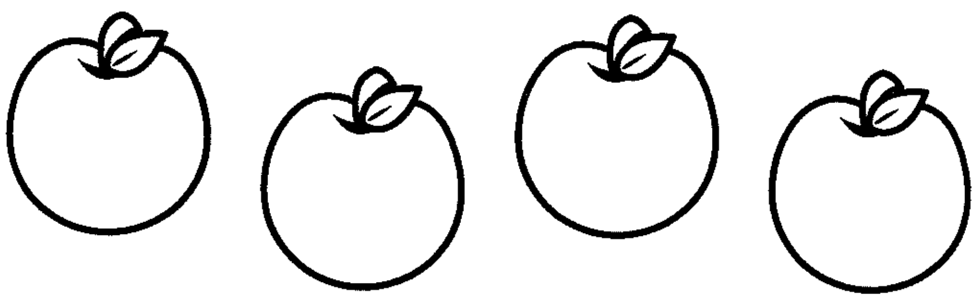
Name ____________________

Directions: Trace the numbers. Draw a ring around the number of objects to match the number.

1



2



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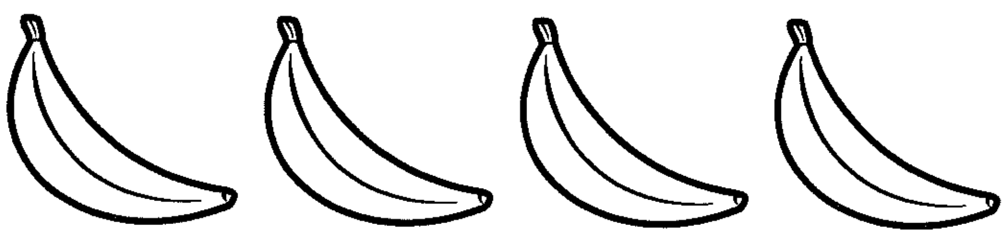
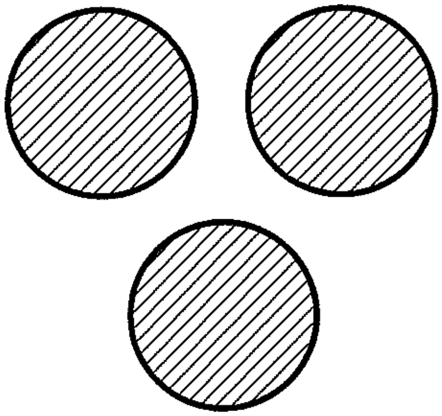


Name ______________________________



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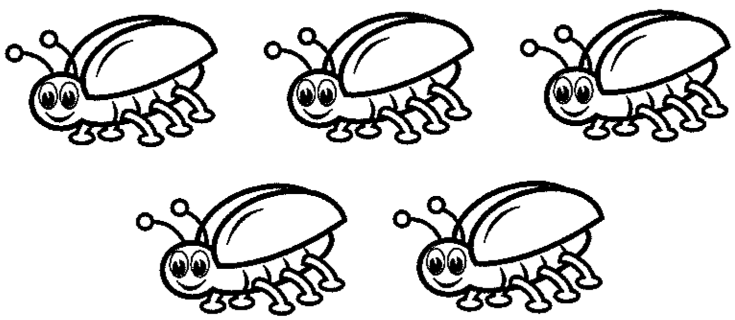

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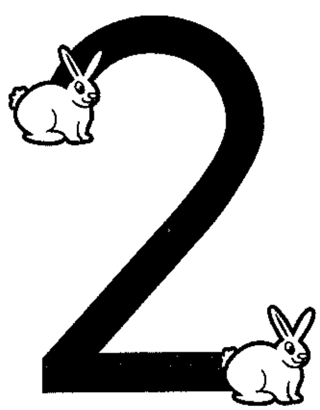


2

4

Name ______________________________

Directions: Write the missing numbers in the boxes. Write the answers on the lines.

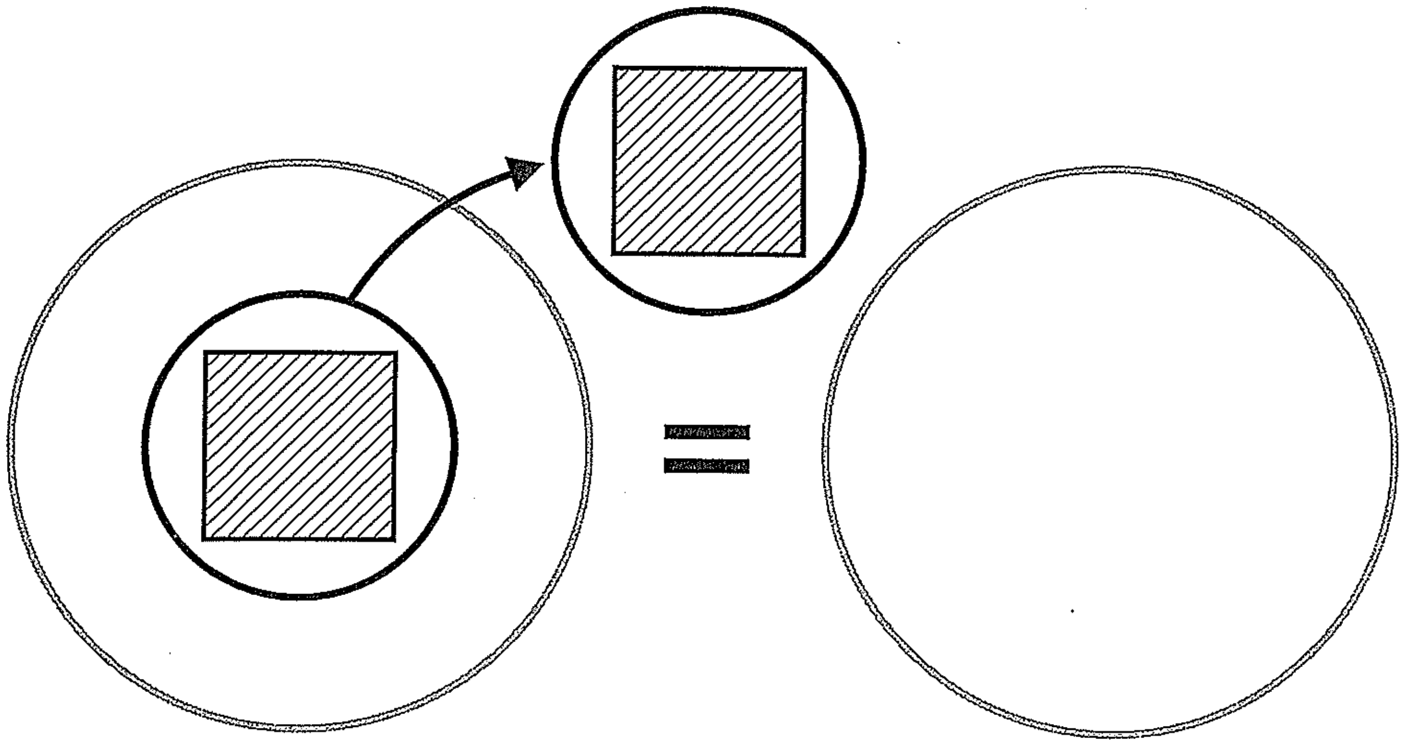
4 + 1 = ______

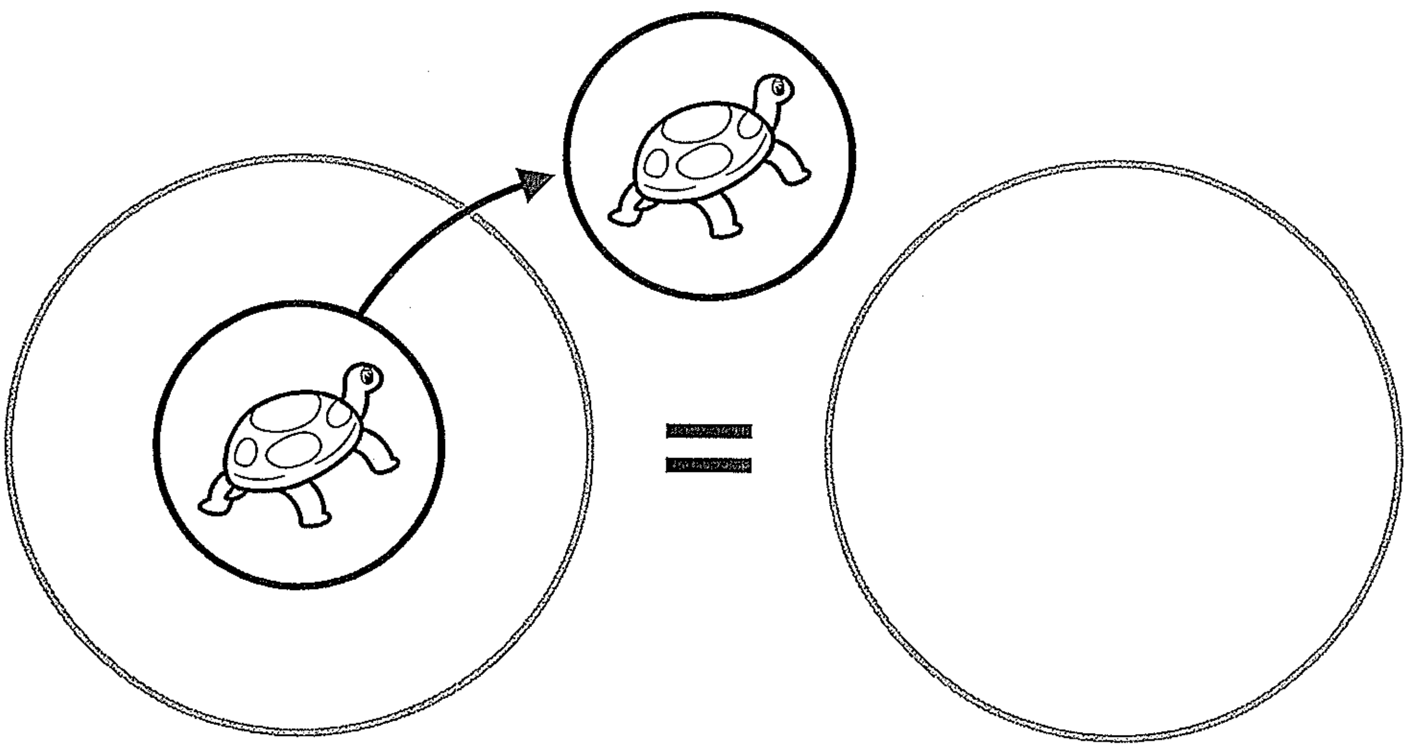
---

4 + 1 = ______

☐ + ☐ = 5

Name ____________________





Oral Counting Tracking

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

Appendix D

Created with http://www.lefthandlogic.com/php/numberfly/numberfly.php

View Answer Key

Probe Type: Number Identification

8	2	3	4	1	5	7	0	6	9
8	5	9	7	4	2	3	6	1	0
3	5	7	1	2	0	9	8	4	6
1	5	9	3	7	8	6	0	4	2
9	2	5	8	0	4	1	7	3	6
7	3	6	1	8	4	2	9	0	5

9	1	6	5	8	2	0	7	4	3
3	0	4	5	9	6	1	2	8	7
3	4	1	5	7	9	8	0	6	2
9	1	3	6	4	8	7	2	0	5

Created with http://www.lefthandlogic.com/php/numberfly/numberfly.php

View Answer Key

Probe Type: Missing Number

4 __ 6 7	1 __ 3 4	2 3 4 __	1 2 3 __
5 6 7 __	3 4 5 __	3 __ 5 6	1 2 __ 4
6 7 8 __	2 3 __ 5	6 7 8 __	1 2 3 __
3 4 5 __	__ 2 3 4	__ 1 2 3	1 __ 3 4
2 __ 4 5	__ 1 2 3	1 2 3 __	1 2 3 __
2 __ 4 5	3 4 __ 6	__ 3 4 5	__ 4 5 6
2 3 __ 5	1 __ 3 4	4 5 __ 7	__ 4 5 6
__ 7 8 9	2 __ 4 5	__ 7 8 9	4 5 6 __
__ 5 6 7	2 __ 4 5	3 4 __ 6	2 __ 4 5
6 7 __ 9	5 6 __ 8	__ 4 5 6	5 6 7 __

View Answer Key

Probe Type: Quantity Discrimination

5	8	2	6	3	7	1	4
7	0	5	2	3	2	6	3
6	5	4	2	6	1	4	3
1	7	8	7	8	5	0	2
4	2	2	5	8	7	2	8
3	8	6	3	6	4	3	5
1	8	1	0	1	6	0	6
2	6	1	0	5	6	1	4

1	4	1	3	3	7	5	4
5	2	2	4	3	6	0	1

Curriculum-Based Assessment Mathematics
Single-Skill Computation Probe: Student Copy

Student: Date: ____________________

7 + 1	6 + 2	6 + 1	5 + 2	1 + 5
1 + 4	5 + 2	6 + 2	3 + 5	2 + 6
6 + 1	2 + 6	1 + 6	4 + 4	2 + 6
1 + 6	6 + 3	4 + 3	5 + 1	8 + 1
4	1	2	5	2

+ 2	+ 2	+ 3	+ 2	+ 7

4 + 2	6 + 1	4 + 4	5 + 1	5 + 2

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Curriculum-Based Assessment Mathematics
Single-Skill Computation Probe: Student Copy

Student:

Date: ____________________

$6 - 1$	$2 - 1$	$9 - 3$	$4 - 3$	$2 - 1$
$9 - 6$	$7 - 4$	$2 - 1$	$5 - 2$	$8 - 6$
$6 - 1$	$9 - 4$	$6 - 2$	$5 - 2$	$6 - 2$

$\begin{array}{r} 6 \\ \underline{-\ 4} \end{array}$	$\begin{array}{r} 8 \\ \underline{-\ 3} \end{array}$	$\begin{array}{r} 5 \\ \underline{-\ 1} \end{array}$	$\begin{array}{r} 4 \\ \underline{-\ 1} \end{array}$	$\begin{array}{r} 4 \\ \underline{-\ 3} \end{array}$
$\begin{array}{r} 3 \\ \underline{-\ 2} \end{array}$	$\begin{array}{r} 3 \\ \underline{-\ 2} \end{array}$	$\begin{array}{r} 4 \\ \underline{-\ 1} \end{array}$	$\begin{array}{r} 8 \\ \underline{-\ 7} \end{array}$	$\begin{array}{r} 9 \\ \underline{-\ 6} \end{array}$
$\begin{array}{r} 9 \\ \underline{-\ 1} \end{array}$	$\begin{array}{r} 2 \\ \underline{-\ 1} \end{array}$	$\begin{array}{r} 7 \\ \underline{-\ 6} \end{array}$	$\begin{array}{r} 5 \\ \underline{-\ 2} \end{array}$	$\begin{array}{r} 7 \\ \underline{-\ 6} \end{array}$

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Interview Questions

1. Do you like math?
2. What do you like about math?
3. What do you not like about math?

Appendix E